THE ENGINEER

OCTOBER 10, 1952

Railway Accident at Harrow

ON Wednesday morning last, two express trains and a local train were involved in an accident at Harrow and Wealdstone station, on the London Midland Region of British Railways. At the time of going to press the full extent of the casualties was not known, but it was apparent that the accident was likely to prove one of the worst railway disasters in recent times. The accident occurred at Harrow and Wealdstone station at 8.25 a.m., when the Perth-Euston night express ran into a Tring-Euston train, which was on the same track. A few seconds later the Euston-Manchester train collided with the wreckage.

Education and Training of Metallurgists

THE Joint Committee on Metallurgical Education has issued a report entitled " The Education and Training of Metallurgists," which is the result of a further examination of metallurgical education following the publication in 1950 of the Committee's Recommendations on University Full-time Degree Courses in Metallurgy. As a result of the survey, the report states that the committee still considers that the universities are the chief source of high-grade technologists and that the university schools should increase, not only the output of technologists, but should provide instruction in industrial science, management and administration and give the opportunity for a study of the humanities. Employers are recommended to make the fullest use of post-graduate courses by financing the attendance of suitable employees and the report goes on to suggest the adoption of formal methods for training graduates immediately they enter industry. Since more technologists are needed than can be supplied by the universities it is recommended that a few colleges of technology should be upgraded and equipped for the education of high-grade technologists. Another recommendation in the report is that instruction in elementary subjects should be physically separated from that in higher technological subjects and that the standard of staffing in technical colleges should be raised. Active collaboration in various fields between colleges of technology and employers is suggested and the report puts forward the view that the examinations in metallurgy for non-university students should be rationalised and that the Associateship of the Institution of Metallurgists should be the goal for all such students.

Joint Committee's Report on Measurement of Productivity

A JOINT committee of the Institution of Production Engineers and the Institute of Cost and Works Accountants has now issued a report entitled " Measurement of Productivity—Work Study Application and Training." It surveys the application of work study in industry and recommends a detailed syllabus for training in work study as the basis for an accepted course and a recognised standard of competence. Although, the report points out, time study is the most suitable way of setting standards of performance and measuring effectiveness, there are serious inconsistencies in time study practice. Since, moreover, questions of method, flow of materials, quality, and so on, are also involved in productive efficiency, the application of work study which comprises methods of study, motion study, time study and job evaluation is necessary. The Committee finds, however, that insufficient use is made of time study in industry to-day. A more widespread application of work study depends on a full recognition of its value by management and on the efforts of properly trained work study engineers. Better facilities for training and above all, a commonly accepted system of training, leading to a recognised standard of competence are, therefore, essential. existing facilities for training, ranging from company schemes, industry schemes like the Cotton Board's school, and consultants' training schemes, to technical college and professional institution schemes, as well as the subjects studied are reviewed in the report for their bearing on the committee's proposals. The report suggests the kind of qualifications needed, but observes that unless industrialists release suitably experienced men, and unless teachers are adequately paid, too few will be available. Advances in industrial technique must be given full consideration in training and the report indicates some pertinent trends. This report goes a long way towards solving some of the problems brought to light in the Joint Committee's Interim Report of 1949. General acceptance of the syllabus of training would help to raise the standard of work study practice and increase the number of competent technicians. The committee has recognised the difficulties, but has made its recommendations for overcoming them. Perhaps the most important need at the moment, it is stated, is the realisation by managements of the value of work study and their support for the objectives which the Joint Committee's Report seeks to attain.

The Churchill Gold Medal

AT the opening meeting of the new session of the Society of Engineers, which was held in London last Monday evening, the Churchill Gold Medal was presented to Air Commodore Sir Frank Whittle, K.B.E., F.R.S. Both Mr. Churchill and Sir Frank are honorary fellows of the Society, which was established in 1854. During the immediate post-war years the council of the Society gave a great deal of consideration to the permanent commemoration of the close wartime association between Mr. Churchill, the Prime Minister, and engineers. Ultimately, the Society decided to establish the Churchill Gold Medal, to be awarded every two years for the most noteworthy contribution to contemporary engineering, the recipient to be selected by the honorary fellows and past-presidents of the Society of Engineers. The choice of Sir Frank Whittle as the first recipient of the medal has been warmly approved by all the members of the Society and by Mr. Churchill himself. Sir Frank's work on jet propulsion is well known; as was recalled at last Monday's ceremony, the first Whittle engine was tested in 1937, and in May, 1941, the Gloster-Whittle experimental aircraft made its first flight. The presentation of the medal was made by Mr. R. S. V. Barber, president of the Society of Engineers, who spoke of the incalculable service which Sir Frank had given to engineering. Mr. Barber also commented on the fact that the first award of the Churchill Gold Medal was an historic occasion, coinciding as it did with the opening of the Society's ninety-ninth annual session. In making acknowledgment of the award, Sir Frank Whittle said that he had received that day a letter from Mr. Churchill, who expressed pleasure at his being the first recipient of the medal.

Resignation of Mr. A. P. Good

ACTING upon medical advice, Mr. A. P. Good has had to reduce his business commitments and has resigned his position as managing director of the Brush Electrical Engineering Company, Ltd. It was evident that Mr. Good was not in the best of health after his world tour of two years ago, and a deputy was appointed against the day of his possible retirement. Mr. Good, who was born at Foxrock, near Dublin, in 1906, and educated at Marlborough, took his law degrees at Oxford. He has been associated with the company for fifteen years, and was the architect of the Brush A.B.O.E. group. He will remain a director and deputy-chairman of the company. The new managing director is Mr. Miles Beevor, who has acted as deputy managing director since early 1951. He was appointed chief legal adviser to the London and North Eastern Railway in 1943, becoming chief general manager four years later. Mr. Ian T. Morrow, who led the British Productivity team on management accounting on a tour of the United States, now becomes the deputy managing director.

Maintaining Airworthiness in Operation

THE eighth British Commonwealth and Empire Lecture, entitled " Maintaining Airworthiness in Operation," by Mr. R. E. Hardingham, was read before the Royal Aeronautical Society on Thursday, October 2nd, at the Institution of Mechanical Engineers, Storey's Gate, London. The paper dealt primarily with a broad explanation of the arrangement in the United Kingdom for the maintenance of transport aircraft, and showed the extent to which the operator, the pilot, the engineer and the Airworthiness Authority were involved. The subject was dealt with in three distinct parts, namely, suitability, serviceability and simplicity. The suitability section discussed the factors involved in the initial certification of the aircraft, the preparation of the Flight Manual and particularly the section of the Flight Manual dealing with the characteristics of the aircraft and its performance where such data should be clearly defined and scheduled. The importance of interpreting and applying this performance data was then discussed. In the second part dealing with serviceability methods for ensuring that the original standard of airworthiness is maintained from one flight to another, were examined, and factors affecting the reliability of the engines and equipment were reviewed. The last part of the paper related to the growing complexity of aircraft and contained the author's views on desirable trends in the future. He stated that accident statistics showed a high percentage due to human error, which in his opinion indicated that the operation and maintenance of the modern complicated aircraft made too great a demand on the skill and vigilance of the crew and engineers.

Premier Grade Petrol

IT was announced by the Ministry of Fuel and Power last week that premier brands of petrol, after an absence of thirteen years, will be reintroduced in the United Kingdom as from February 1, 1953. Commenting on this decision, Mr. Leonard Sinclair, chairman and managing director of the Esso Petroleum Company, Ltd., mentioned several advantages which will result from the use of higher grade petrol. In particular, he mentioned the important influence it would exercise in engine design, enabling the motor industry to develop engines employing higher compression ratios to meet competition in overseas markets. It would also make possible greatly improved performance and more economical running with present cars. Of even greater significance, Mr. Sinclair continued, was the fact that with the removal of this control, the oil companies could exploit the full capacity of the catalytic refinery installations which will become available shortly. Of the six catalytic refinery installations in this country two are at present on stream and the others are expected to be in operation by the beginning of next year. The total cost of this equipment is estimated at £20 million. A factor which had delayed the reintroduction of such petrol was the cost in dollars of tetra-ethyl lead needed in its preparation, but a plant to satisfy this requirement will be in operation in this country within about a year. It is anticipated that the new grades will probably cost about threepence a gallon more. Pool petrol will continue to be sold, however, under each company's brand names and the maximum price ruling for pool petrol will remain in force.

The International Machine Tool Exhibition at Olympia

No. III—(*Concluded from page 443, October 3rd*)

IN the columns below, we conclude our review of the exhibits at the International Machine Tool Exhibition. The exhibition was held at Olympia and closed on October 4th.

Herbert Hunt and Sons, Ltd.

Several of the special machines designed and made for the manufacture of drills, taps, reamers and milling cutters were exhibited by Herbert Hunt and Sons, Ltd., Old Trafford, Manchester.

One of these machines is the five-spindle automatic drill fluting machine for drills

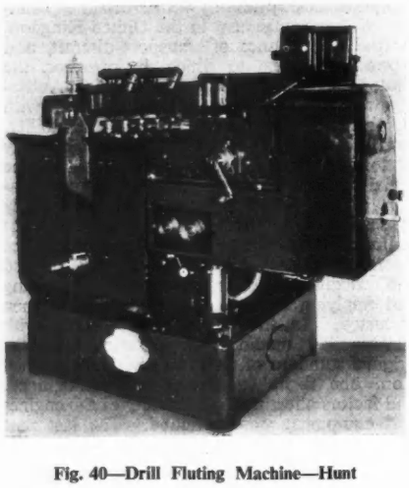

Fig. 40—Drill Fluting Machine—Hunt

from $\frac{3}{16}$in to $\frac{1}{2}$in., shown in Fig. 40. In this machine five blanks are fluted simultaneously by climb milling in a completely automatic cycle. The cutter spindle is driven at 110 r.p.m. by a 3 h.p. motor through a duplex chain to a worm and worm wheel. The blanks are carried in special collet holders in a slide, which can be fed towards the cutters at speeds variable between 1in and 5in per minute. Helix angles between 25 deg. and 33 deg. are available through change gears and the web taper on the blanks is produced through a solid inclined bar.

In the machining cycle, when the first flute has been cut, the table carrying the blanks is lowered to clear the blanks from the cutters, before it retracts rapidly to the starting position. The blanks are then automatically indexed through 180 deg. before being fed towards the cutters for the second fluting operation. When the table again drops and retracts at the end of the second operation it is automatically stopped.

Acbars, Ltd.

The Continental machine tools on the stand of Acbars, Ltd., 57a, Holborn Viaduct, London, E.C.1, included the Italian built "Cima" automatic universal gear hobber, illustrated in Fig. 41. This machine is designed to cut spur and helical gears up to 21·65in diameter by 5 D.P. in blanks up to 6½in high. The machine is rigidly designed and built to precision limits with all parts amply dimensioned to give quiet operation and long working life.

A 2½ h.p. electric motor in the base drives the machine through vee belts and a gearbox giving nine hobbing speeds from 50 to 212 r.p.m. A vertical splined shaft from which the drive is transmitted to the hob through bevel gearing has a large flywheel at the top to ensure even running.

The milling head, which has a tangential attachment, is mounted on an adjustable carriage on the vertical column, and can be swivelled to its angular position by means of a worm gear. The angle of inclination is shown on a large direct reading scale, graduated in degrees and minutes, provided with a vernier.

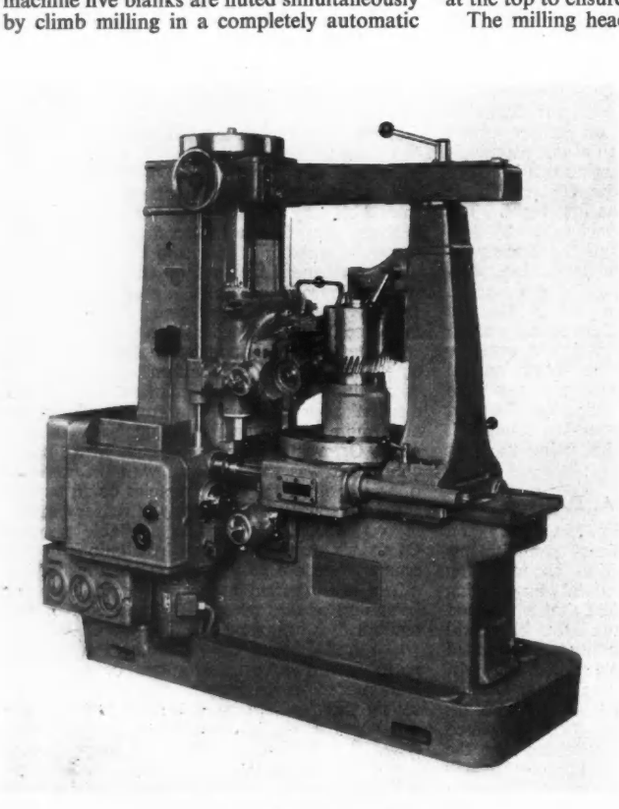

Fig. 41—Gear Hobbing Machine—Acbars

The milling head spindle runs in bronze bushings and is axially and radially adjustable. The spindle slide is provided with hand and automatic controls and will mill multiple start worm gears with high efficiency, using a tapered hob. By the same means endless screws can be generated, using as a tool a rotary Fellows cutter.

The 19in diameter work table rotates on a hand or automatically-operated carriage traversing in the vee-guides of the base. Its dividing mechanism has precision bronze worm gears and a heat-treated adjustable endless screw with ground thread. The hob and table drive ratio is determined through a train of gears which actuates the automatic spacing. The head is provided with vertical and tangential automatic feeds and the work table has automatic horizontal traverse.

The mechanism for the differential is driven through a set of change gears, giving supplementary movement to the endless screw of the work table. The combination of this movement with that actuated by the change gears of the spacing device enables the cutting of helical gears of any angle, as well as worm gears and endless screws.

One of the new Christen drilling machines exhibited is illustrated in Fig. 42. These "Variator" driven drilling machines are

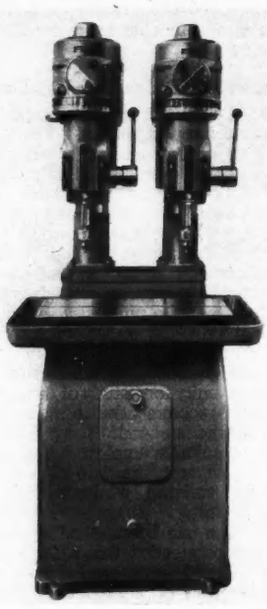

Fig. 42—Drilling Machine—Acbars

driven by a built-in motor through an infinitely variable speed unit and vee belts, which give a wide range of speeds within a ratio of 1 to 100. This spindle speed range is divided into two groups from 70 to 700 r.p.m. and 700 to 7000 r.p.m. without the use of reduction gearing. A speed range selection dial on the front of the head is arranged with segments having different colours, which are exposed according to the position of the adjusting knob. The figures marked on the plate showing the various spindle speeds are also in different colours to correspond with the colours of the segments. The drill spindle has a stroke of just over 3in and is operated by a hand lever, a depth stop being fitted. Holes up to 0·59in diameter can be drilled in steel on this machine.

A small universal grinder for precision work which was exhibited, is made by F. Lli. Lizzini, of Italy, and built to take work up to 10in long between 2⅜in high centres. It has a hydraulically operated table and its wheel runs at 3900–4500 r.p.m.

George Cohen, Sons and Co., Ltd.

The group of lathes and other machines of Continental manufacture shown on the stand of George Cohen, Sons and Co., Ltd., Sunbeam Road, London, N.W.10, included the Mondiale "Selectronic" lathe, illustrated in Fig. 43. This machine has a centre height of 6⅞in and takes work up to 22¼in long between centres. Its drive is designed to combine the advantages of a wide range of

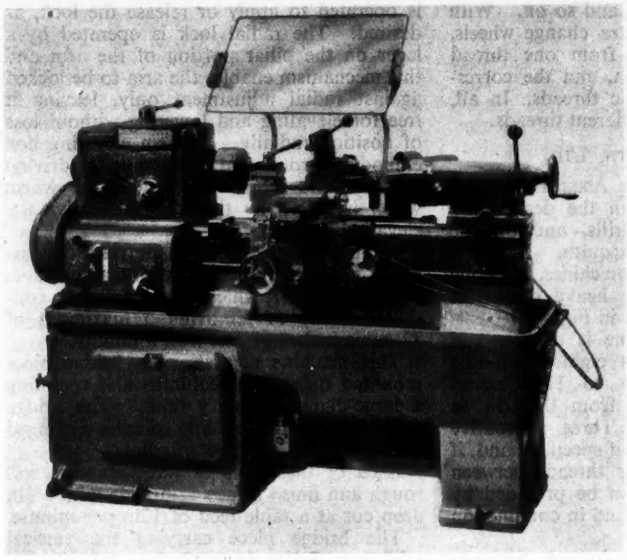

Fig. 43—" Selectronic " Lathe—Cohen

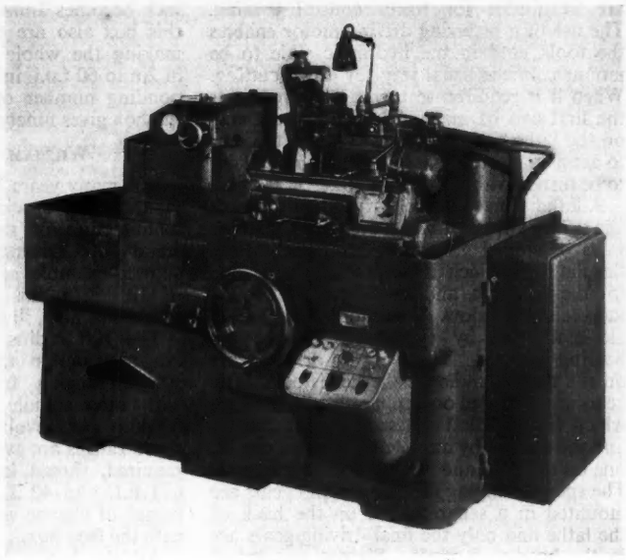

Fig. 44—Thread Grinder—Newall

spindle speeds with preselection and remote control.

The machine is available with three spindle speed ranges from 400 to 3200 r.m.p., 250 to 2000 r.p.m. and 125 to 1000 r.p.m., with infinite variation between the top and bottom speeds in each range. Whilst the machine is operating it is possible to preselect the suitable speed for the next operation and engage it automatically when required. Six longitudinal feeds from 0·002in to 0·024in per revolution and six facing feeds from 0·001in. to 0·12in per revolution are available. A brake fitted to the spindle is operated by the same lever as the driving clutch, and starting and stopping of the spindle is effected almost instantaneously even with the highest speeds.

The machine can also be supplied with a copying attachment at the rear, as shown in the illustration.

Other equipment on this stand included four of the well-known " Raskin " power presses, the " Coburn " double-ended punch and shear, and two examples of the Weybridge gang slitter.

Newall Group Sales, Ltd.

The equipment made by the Newall Engineering Company, Ltd., Peterborough ; Optical Measuring Tools, Ltd., Slough ; and Keighley Grinders (M.T.), Ltd., Keighley, was shown on two stands and included a number of new machine tools.

One of the new machines is a jig borer, which is a development of the Newall No. 2 model. This machine is fully hydraulic and is fitted with a table 24in by 42in, having a longitudinal traverse of 36in and a cross traverse of 24in. It incorporates a number of improvements, including a completely redesigned spindle and quill designed for accurate machining and yet able to withstand milling cuts without loss of accuracy. The distance from the spindle to the table is increased to a maximum of 31½in and a new system of power feed gives eight feeds from 0·0005in to 0·012in per spindle revolution.

A new " N.L." thread grinder (Fig. 44) was shown grinding taps. This machine can be fitted with a range of useful auxiliary equipment, including an internal and hob grinding attachment and a surface grinding attachment. The wheel dressers available for it include pantograph dressers using a fifteen times and a four times magnification between the master formers and the diamond. These dressers can be used to produce multi- or single-rib formed wheels, special profiles, angles, &c.

A " Rigidlap " universal lapping machine demonstrated is designed for production lapping flat or cylindrical surfaces on components. It is fitted with a bridge column designed to eliminate deflection or distortion during lapping and uses 24in or 28in. diameter wheels rotating in opposite directions. The top lap is raised and lowered by hydraulic gear.

A Keighley universal grinder which was exhibited has the wheel head mounted on massive turntables to ensure rigidity and the work head is also mounted on a turntable. In this machine the grinding wheel can be mounted at either end of the wheel head spindle. Its internal grinding spindle can quickly be swung into grinding position and the work head changed rapidly from live to dead centre as required. Means of rapid approach and run back of the wheel head are provided through controls interlocked to prevent the operation being carried out whilst grinding is in progress.

A new machine exhibited for the first time by Optical Measuring Tools was a 30in optical rotary projection table, stated to be capable of reading direct to one second of arc.

Willson Lathes, Ltd.

The group of lathes shown by Willson Lathes, Ltd., of Ovenden, Halifax, included a general-purpose 8½in centres, 8ft bed machine which, in addition to being suitable for all classes of general work, is fitted with a hydraulic tracer unit. This lathe is driven by a 7½ h.p. reversing motor and has nine spindle speeds from 52 to 945 r.p.m. Its quick-change feed gearbox gives a range of twenty-four threads from 4 to 28 t.p.i., and feeds from 0·02in to 0·003in per revolution of the spindle.

As can be seen from the photograph of the machine which we reproduce in Fig. 45, a four-way tool post is fitted on the front slide and its use in normal operation is in no way interfered with by the hydraulic tracer slide mounted at the rear. Tools can be mounted on the front slide for cutting off, forming grinding lands and small radii which

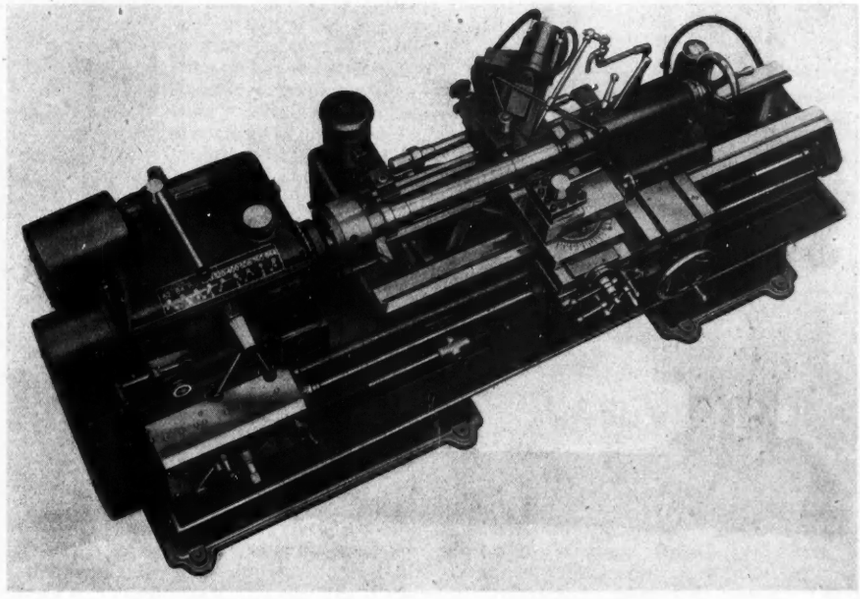

Fig. 45—Tracer-Controlled General-Purpose Lathe—Willson

are unsuitable for tracer control turning. The use of a reversing driving motor enables the tools used in the hydraulic slide to be mounted in the usual way for down cutting. When it is required to turn a batch of parts the first can be machined in the usual way on the lathe and then transferred to the rear to act as a master template for the remainder to be turned with the tracer unit.

A lathe of new design for production work has a 24in swing. Its box design bed has vee ways of chilled grey iron positioned below the flat top, which is used solely as a slide for the tailstock, and also serves to protect the vee slides below. The saddle is traversed along the bed by a rack set between the bearing surfaces. There are no driven gears on the main spindle on the headstock. The gears are mounted on a separate quill through which the spindle is passed without contact and the drive is by means of two dog clutches, one on the quill and the other on the spindle. The speed changing mechanism and gears are mounted in a separate box on the back of the lathe and only the final driving gears are in the headstock itself. Sixteen speeds are provided in geometric progression from 20 to 1000 r.p.m. Changing gear is by rotating a dial conveniently placed in front of the headstock. One complete turn changes from one speed to the next.

The feed shaft and guide screw are placed inside a pocket in the bed side and are fully protected from falling grit and swarf. The lead screw is of ample dimensions and is supported at intervals along its length. The feed shaft is fitted with an adjustable friction clutch designed to slip should the saddle become blocked through any reason.

The gearbox incorporates a coarse screw-cutting motion which, by the movement of a lever, multiplies the standard range of 2 to 15 t.p.i. by four, giving the fastest screwcutting pitch of 2in lead, and the rest of the range to correspond. Movement of another lever changes the whole range from threads per inch to millimetres pitch, i.e. two threads per inch becomes 2mm pitch, and so on. With this box also are two extra change wheels, making the whole range from one thread in 2in to 60 t.p.i. in English, and the corresponding number of metric threads. In all, the box gives ninety-six different threads.

William Asquith, Ltd.

For many years William Asquith, Ltd., of Halifax, has specialised in the design and manufacture of radial drills, and on the stand of Drummond-Asquith, Ltd., it showed examples of these machines, from one of 3ft 2in radius to the heavy duty 10ft radius machine, illustrated in Fig. 46.

The 10ft radius machine is of new and advanced design and has eighteen spindle speeds ranging from 14 to 1100 r.p.m. with nine spindle feeds from 0·002in to 0·040in per revolution. Three alternative speed ranges are available if specified, and, if required, thread leads for threads between 6 T.P.I. and 40 T.P.I. can be provided by means of change wheels used in conjunction with the feed box.

All the levers and handwheels for controlling the machine are grouped on the spindle slide to give ease of access and manipulation with the arm in all positions. With the self-applying design of spindle feed fitted the spindle is wound down until it touches the work and a slight continuation of this movement automatically puts the power feed into operation. Reverse movement of the feed handwheel first disengages the feed and then withdraws the spindle. A graduated trip dial can be set to disengage the feed automatically at any point in the spindle travel.

Two controls, one mounted on the right of the slide and the other on the underside, when operated in conjunction with each other, provide simultaneous mechanical lock to the slide on the arm and the arm on the pillar. One of these controls, a knob, is set to the required position indicated on the dial over which it is centred, and the other, a lever, is operated to apply or release the lock, as desired. The radial lock is operated by a lever on the pillar portion of the arm and this mechanism enables the arm to be locked against radial adjustment only, leaving it free for elevating and lowering without loss of position radially. An arm elevating box embodies a rotor and stator unit for driving a worm and worm wheel, and the worm wheel is internally threaded to receive the elevating screw.

Another interesting machine made by this firm is the continuous rotary milling machine, shown in Fig. 47, which is designed for a continuous duty of removing a maximum of 72 cubic inches of cast iron a minute.

This machine consists of a bridge piece mounted on vertical columns and spanning a large-diameter rotary table. The bridge carries six vertical milling spindles arranged in two groups of three spindles.

Each of these sets of three spindles will rough and finish a face 12in wide with a $\frac{1}{4}$in deep cut at a table feed of 12in per minute.

The bridge piece carrying the vertical milling spindles is manufactured in two similar parts, each part being supported by the central column at one end and an outer column at the other, thus forming a bridge over each half of the table. The spindles are mounted on anti-friction bearings in large diameter sleeves and have $5\frac{1}{16}$in British Standard spindle ends arranged for carrying cutters fastened with screws. Each spindle has its own 10 h.p. driving motor, driving through vee ropes, speed slip gears for speed changes, and a final worm and wheel. The spindle sleeve is adjusted vertically by a rack and pinion operated by a handwheel through a worm and wheel. A dial on the handwheel graduated in 0·001in divisions allows accurate setting of the cutters.

The base, which carries the rotary table and its drive, together with the columns for supporting the bridgepiece, has its centre in the form of a well in which the table is mounted on a large central bearing.

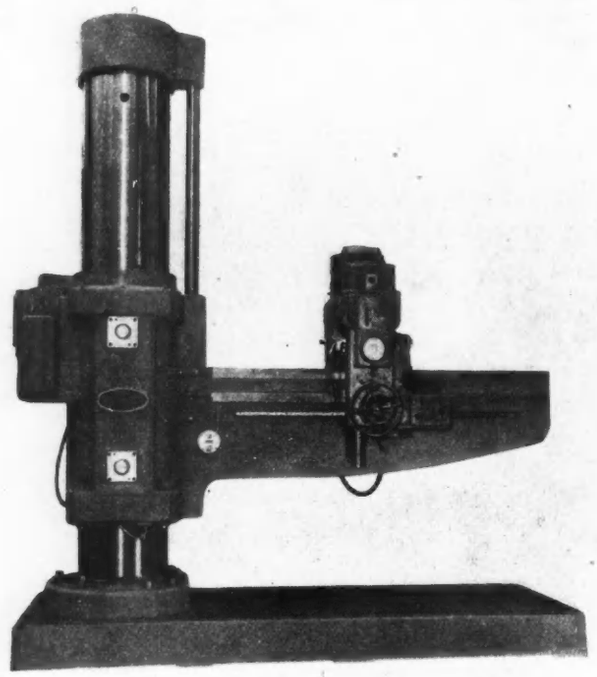

Fig. 46—10ft Radial Drilling Machine—Asquith

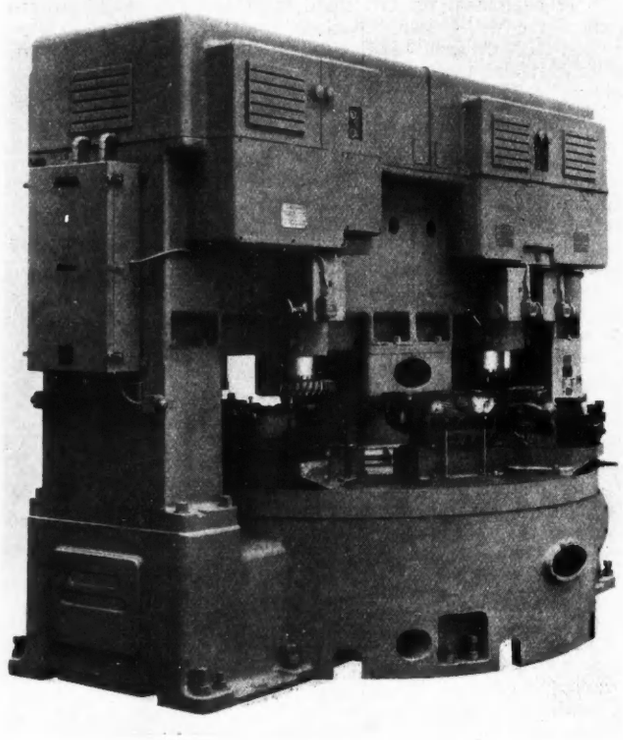

Fig. 47—Continuous Rotary Milling Machine—Asquith

A worm for rotating the table is mounted solidly in the base and takes its drive from the table feed box, which is a separate unit in itself.

The table feed box is driven by a 5 h.p. motor through vee ropes, reduction gears, feed slip gears and a final worm and wheel on to the table feed wormshaft passing through the base. A clutch operated by a hand lever selects either "feed" or "quick rotation" to the table and an adjustable spring-loaded slipping clutch is incorporated in the drive as a safety measure. The feed slip gears arranged at the end of the feed box under a readily detachable cover, give table rotation rates of from 1 revolution in ten minutes to 1 revolution in forty minutes.

WEATHERLEY OILGEAR, LTD.

The three presses which were shown, together with representative examples of broaching machines made by Weatherley Oilgear, Ltd., of Arch Street, London, S.E.1, included the 60-ton capacity horn press, illustrated in Fig. 48.

This hydraulic press has an adjustable stroke up to 7in long with a daylight of 19in. Its "Oilgear" pump is driven by a 20 h.p. motor and the maximum speeds are 80in per minute down and 110in per minute up. In the operating mechanism provision is made for either distance reversal for blanking and piercing operations or pressure reversal for riveting and coining operations.

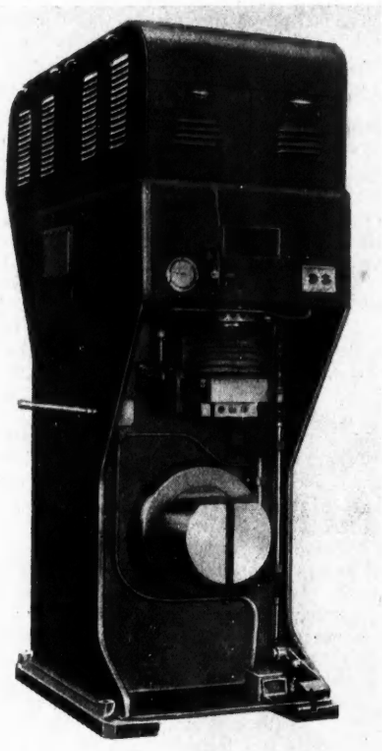

Fig. 48—60-Ton Horn Press—Weatherley

With the machine cycle set for distance reversal, when the foot lever is depressed the ram moves down until a ram arm moves the control shaft into reverse through a toggle mechanism, which gives instantaneous full-speed reversal. When the ram reaches the top of the stroke the arm moves the control shaft to the neutral position and the ram movement stops.

If short repeat strokes are required, as in coining or riveting, the operator moves his foot from the pedal to a switch at the side. As long as this switch remains depressed the ram operating cycle continues and when the pressure is released the ram returns to its top of stroke position. This repeat short stroke can be adjusted down to ½in per minute through a cam-operated limit switch.

The machine can be arranged for pressure reversal by opening a globe valve and changing the springs on the snap action mechanism to an alternative position, where they act as return springs. Then when the foot lever is depressed the ram moves down to build up pressure on the work and reach the required tonnage with the top of the stroke.

MACHINE SHOP EQUIPMENT, LTD.

One of the many Continental machines, designed particularly for the mass production to precision limits of small components, which were exhibited at Olympia was the "Variomatic" automatic drilling and tapping machine on the stand of Machine Shop Equipment, Ltd., Spenser Street, London, S.W.1.

This machine consists of an assembly of individual heads for drilling and tapping arranged round a central indexing table carrying work-holding fixtures. These heads are held rigidly by special clamps. Indexing drilling and tapping and, if required, ejection of the finished component are automatic. Control of the machine cycle is usually effected by means of a Bowden cable from one of the drilling units to the indexing unit, and then from the indexing unit to the three other working heads. In certain cases the cycle is initiated from one of the tapping units fitted with a special attachment.

This firm also showed the "Fette" self-opening thread rolling head, which can be fitted to most ordinary machine tools for rolling instead of cutting threads; the "Armag" profiling head, for cutting square, hexagonal and other profiles internally and externally, when used on lathes, drilling machines, &c.; the "Wohlhaupter" universal facing and boring head; and a selection of "Perfect Grip" arbors, mandrels and chucks.

A Gas Turbine Electric Experience

By EDWARD H. LIVESAY

No. II—(*Concluded from page 446, October 3rd*)

The Metrovick gas turbine electric locomotive, the first such locomotive to be built in this country, has a maximum tractive effort of 60,000 *lb and a continuous tractive effort of* 30,000 *lb. It is the most powerful express locomotive built in Britain. Mr. Livesay describes cab experiences with this locomotive drawing the* 400 *ton "Merchant Venturer" to Bristol and the* 445 *ton "The Bristolian" back to Paddington, light work for so powerful an engine.*

"THE Bristolian" left Temple Meads station at 4.16 p.m., in a drizzle; the load was 445 tons net. The master-controller was at the 80 deg. mark on the segment, the maximum being 110 deg., corresponding to a tractive effort of 60,000 lb. This marked segment is the chief means by which the driver can gauge what he is asking of the power supply—it is equivalent to a combination of regulator and cut-off. The Bath stop took place at 4.35 p.m., and the final exit, after the usual double stop due to the short platform, at 4.40 p.m., with the turbine making 6000 revolutions. Its maximum safe working temperature is 700 deg. Cent., and it may be mentioned that the overall expansion of the whole power unit is about ¼in; it is anchored at the generator end, all movement being in the direction of the turbine.

There had been no adverse gradients whatever in running west, but facing the other way there were two steep banks ahead—Box tunnel and Dauntsey, both rising 1 in 100, the former 2½ miles in length, and the latter 1½ miles. "The Bristolian" passed Box station and entered the tunnel at 52 m.p.h., leaving it at 44. The unanimous opinion in both cabs was that this was better than a 4–6–0 "King" could achieve with a similar load, 445 tons. Knowing nothing about this—and not caring very much!—I remind the reader that this was the opinion of the railwaymen on the engine, who were on home ground, and presumably know their stuff. If, however, some "timing and measuring" fanatic thinks he can produce figures to refute this statement, would he please forward them to the Western Region people for the necessary disciplinary action.

Emerging from Box tunnel, the speed rose to 75 m.p.h., at which the foot of the Dauntsey incline was reached; it was topped at 66 m.p.h., a respectable figure on 1 in 100, and again the enginemen expressed approval. Here I was told that the speed-indicator understated the facts by 4 m.p.h. Then came what I have often seen referred to as "the Wootton Bassett bank"—5½ miles of 1 in 660. If that is a bank, what is an incline? In any case, No. 18100 paid no attention to this acclivity (I have just noticed it is called an "incline" in the gradient book—you pays your money and takes your choice as to what you call it) and

Fig. 4—Front of Locomotive

shortly after, the train passed through Swindon at 70 m.p.h., at 5.10 p.m., 4½ min early. Again the smoother motion over f.b. rails was recorded; between Challow and Wantage Road there was a 60 m.p.h. restriction, and after picking up, Didcot was passed at 75 m.p.h. "The Bristolian" was to make an out-of-the-ordinary stop at Reading; there had not

been enough room in the slip coach for all the passengers who wanted to detrain there, and some had been accommodated in the other part of the train. There was a momentary signal-stop just outside at 5.43 p.m., well ahead of schedule—the working timetable mentioned 5.54 p.m. for passing, so the average had been 74·5 m.p.h. from Swindon. The 71 miles from Bath had been covered in 63 min, 67·6 m.p.h., over the heaviest part of the route, this being the highest start-to-stop average recorded during the day. The restart from Reading proper was made at 5.47 p.m.

The two land-slips near Twyford brought reductions as before, and I went to the rear cab, again forgetting that persuasive fan-inlet, and had the same difficulty in tearing myself away from its fond embrace. Everything was going on as peacefully as usual in the turbine-room ; white flame was showing in the combustion chamber window.

The musical high-pitched song of turbine and compressor was still fighting a losing battle against the roar of the gale raging through the air filters, which made conversation with the attendant impossible, or, at any rate, too much trouble. We were nearing " the smoke " now—Acton went by at 6.24 p.m.—there was a lengthy signal slow down to 5 m.p.h. approaching Westbourne Park, and a dead stop at the Paddington signals which spoiled the early figure expected for coming to a stand at the arrival platform, to the disappointment of the crew. " The Bristolian " came to a halt at 6.33 p.m., 2 min ahead of time, having covered the 118 miles from Bristol at an inclusive average of 50·9 m.p.h. This is typical of what I have noticed on all the fast trains upon which I have travelled in Britain recently—they are all slower than they were before the war ; I believe " The Bristolian " was a two-hour train in those days. Apparently the permanent way is chiefly responsible for this retardation ; certainly No. 18100 could have equalled or bettered the old timing, stops included, if necessary, as no effort was made to extend the engine—it was working well within its power throughout, even up the Box and Dauntsey inclines. Thus ended one of the most interesting and thought-provoking footplate runs I have ever made, all the more informative and enjoyable because of the unfailing courtesy and co-operation of everyone concerned.

What were my conclusions ? Very favourable, though the use of the phrase may sound pretentious seeing that is based on a mere 250 miles on an entirely novel type of engine embodying principles and design with which I am not familiar. So far as I am concerned the whole thing breaks new ground, in which new seed has been sown, and from which I have attempted to harvest a crop without waiting for some of it to germinate ! · This account, however, describes what happened during the runs ; nothing showed the least sign of going wrong. The engine was master of its task, was easily handled, and reached a speed of about 80 m.p.h. without being " let out." No attempt was made at really fast running—the train was checked several times by signals. When there were any gradients—and there were only two stretches of 1 in 100 totalling 4 miles going east at that—the engine showed something of what it could do by exceeding the best that the most powerful class of steam locomotive on the line could do (will " basic design " enthusiasts please refer back to what was said on this subject in a previous paragraph ?). These two runs were in no way a real test of the engine's capabilities, neither the load nor the route imposing any stress ; but so far as they went they were valuable as a " study " of what it could do, and I hope will do in the future. I should like to see No. 18100 really extended at the head of a 600-ton train between Paddington and Penzance, which would be a real test, but for more than one reason I am never likely to have that pleasure.

I made no inquiries about the fuel consumption—chiefly because I guessed the information would not be given me ! I did ask whether the engine could be run non-stop from London to Edinburgh, to be told that probably it could, provided the water tank was used for additional fuel, which it can be—and is to be, I believe.§

Had I any criticism ? None of any importance ; perhaps that—but if I mention it again it will come into the same category as King Charles the First's head in the compositions of Mr. Dick. An adequate explanation, in no way derogatory, has been given, anyway. In comparison with the American diesel-electrics on which I have ridden the cab seemed a trifle cramped, and I might draw attention here to the different ideas that evidently have governed the layout of controls and gauges in the two designs. Many more of these have been brought into the cabs of No. 18100 than in the American diesel-electric, where simplicity was the keynote. Beside the two luxurious armchairs, there was nothing in the latter's cab but the controller, brake-valve handles, sander, horn and speedometer, and a couple of dials on the fireman's side, plus headlight switches. I am not even sure that the engines could be started from the cab ; most of the control gear, dials, &c., were under the maintainer's care in the engine-rooms ; the driver had nothing to do with them. This engine, however, was built over a decade ago, and may not be typical of present practice. It has very likely been scrapped by this time, following the American habit of ruthlessly discarding any machine that is not up to date.

What did the enginemen think of it ? Their opinions, too, seemed very favourable. In fact, Fireman Keble was almost enthusiastic, in his quiet way—he had nothing to do ! On this occasion he could not even act as supernumerary in the front cab, there being no room for him, with four people in it already, quite enough for safe navigation.

The engine is undeniably complicated, but considerably less so than a diesel-electric of equal power, the power unit being much simpler. Much of the complication lies in the electrical transmission, in which it is merely the diesel's equivalent. As to cost, I believe a three-unit diesel-electric locomotive of 6000 h.p. runs to £250,000 at the present rate of exchange, and I gathered that two 3000 h.p. gas turbine engines would cost considerably less than this. Mechanical transmission is tempting in theory, but directly one tries to work out a method of transferring the power from a single gas turbine to six driving axles in any other way than electrically, the difficulties are so formidable and the complication so great that even supposing it could be done at all the result would be a mechanical cat's cradle to which the simplicity of an electrical system—if the Hibernianism may be excused—would be much preferable. I am picturing, of course, an engine with the bogies at the ends of the chassis, where they ought to be, and minus any sort of coupling-rods, which are an abomination anyway on a fast-running locomotive, and would be impossible with small wheels. Patrick Stirling put it pithily when he said a four-coupled express engine was " like a laddie running wi' his breeks doon " ; how much more so if they were applied to the above type of locomotive ? The electrical system, despite its complication, is, at any rate, reliable, and will probably hold its own for a long time yet. If pulverised coal can be used successfully—it is being experimented with in America on twin-unit gas turbine engines with a tractive effort of 120,000 lb—fuel cost would probably be considerably reduced.

In conclusion, I am glad to acknowledge gratefully my indebtedness to everyone concerned in the runs for their helpfulness and courtesy, which was shown from first to last. I have already mentioned the Western Region enginemen, who did everything possible to lighten my darkness where their knowledge of the road was of value, or when driving methods were inquired into. It only remains for me to admit my manifold obligations to Dr. Smith and Mr. Seager, of the manufacturing company and their keen staff, and to Mr. Riddles, of the Railway Executive, for giving me the opportunity to travel on this very original and promising locomotive.

§ The Metropolitan-Vickers Electrical Company has since been good enough to inform me : " We expect that fuel consumption figures will be published, and hope they will be for a service better suited to the locomotive's characteristics. A gas turbine does not show good fuel economy on service lighter and slower than those for which it was designed."

The script of this article was submitted both to the Railway Executive and to the Metropolitan-Vickers Electrical Company, Ltd., for " screening," with results that gave me considerable pleasure. The engineers of the latter wrote me a charming letter, in which they were good enough to say—but I have decided, in fairness to them, to give extracts from it:

" . . . We have read your article with great interest and appreciation and in general there is only one feature to which we could take exception—the reference to ' nosing ' ! In order that you may understand our feelings on this matter, we give below some comments from one of our traction engineers who was intimately concerned with the design of the locomotive. Our chief concern is at the removal of King Charles's head—in this context the reputation of our running gear designers—and, in fact, we are not convinced that it should have been necessary to cut it off at all, but that is a matter of opinion and politics ! The quality of the riding achieved is a source of considerable satisfaction to the designers, who had to face the problem, which Mr. Livesay obviously appreciates, of accommodating in each bogie three traction motors big enough for the specified performance, and a suspension and bogie control system suitable for the high speeds required. The mass of the motors is in itself inimical to the best riding. [Exactly, this is just what I was trying to convey ; not that the riding was in any way bad, but that it was not quite so good as I had, perhaps over-critically, expected it to be, and I gave what I concluded might be the explanation, which it seems was more or less correct—the three motors and their mass. To me it appears that the wording of Messrs. Metropolitan-Vickers's comment in itself admits my soft impeachment—' . . . inimical to the best riding.' So we are really in agreement after all !—E.H.L.] Quite apart, however, from such extenuating circumstances, we consider the locomotive a relatively smooth-riding vehicle, and we believe the railway engineers and also the driving staff are well satisfied with its performances in this respect. [So am I !—E.H.L.]

" Strict comparison with other good-riding vehicles is, as Mr. Livesay is well aware, extremely difficult on account of the influence of track conditions, wear of flanges

and other running gear. We are not familiar with the C.N.W.R. 'Paragons,' but would cite three advantages they presumably enjoy, all contributing to good riding :

"(*a*) High axle load with appropriate track. [I don't know about the former, not having the figures, but I don't think the track was responsible—it was of just the ordinary American prewar type.—E.H.L.]

"(*b*) Their riding is judged from a driving cab located over the pivots, whereas 18100's cabs are well outside the pivots (should Mr. Livesay ride on No. 18100 again, perhaps he would check the improved riding, lateral and vertical, in the vicinity of the 'persuasive' motor blowers, i.e. over the pivots. [This is really interesting, and I admit not thinking of it when forming a judgment ; it may well have considerable bearing on the matter.—E.H.L.]

"(*c*) They have bolster springs (though in our view it is not clear that the improvement afforded by these warrants the added complication, cost and maintenance).

"Our concern in this matter is not that Mr. Livesay should have made the criticism, but that the average reader may get an impression out of true perspective, such as 'M-V have made a fine loco, but its riding isn't up to much.' [I quite see the point, and assert with all due emphasis that I should be desolated if the reader formed any such conclusion, which would give me real pain ! Probably, with the C.N.W.R. 'Paragons' in mind, I expected too much.—E.H.L.] Partly this may be because there is no other Monarch to decapitate, but we would be glad if he could effect decent burial sooner after the fall of the axe ! " [Well, even if I haven't exactly buried the corpse, Messrs. Metropolitan-Vickers will admit I have only kept it above ground sufficiently long for dissection.—E.H.L.]

In conclusion, I may point out that Messrs. Metropolitan-Vickers have gone too far in suggesting I have no other Monarch to decapitate ; I have four more ! Since the gas turbine article was written, I have ridden on (*a*) diesel 10001, (*b*) diesel 10200, (*c*) S.N.C.F. electric (Paris/Dijon), and (*d*) ditto, Paris/Le Mans. So far merely as "nosing"—not general all-round riding—is concerned, I would put them in the following order, with the "Paragon" leading the pack, as it certainly did :

(1) C.N.W.R. diesel-electric.
(2) Diesel 10200.
(3) Gas turbine, 18100.
(4) Diesel, 10001.
(5) Paris/Dijon electric.
(6) Paris/Le Mans electric.

The explanation of No. 10200's good path-finding is simple—it has four-axle trucks, the leading axle not being a driver at all and able to move separately from the others ; (4), (5) and (6) might almost be bracketed together—one would need a Hallade recorder to help one to an accurate decision. But however much I may have hesitated before decapitating King Charles, I have no difficulty in awarding the laurels for all-round good riding performance—they go to the "Paragon," whose action was as perfect as that of any vehicle with wheels running on rails is ever likely to be. Floating through space on a piece of rainbow stuffed with cloud is the only method of locomotion I can imagine equal to it.

ANGLO-AMERICAN ENGINEERING AGREEMENT.—R. A. Lister and Co., Ltd., of Gloucester, have informed us that the National Supply Company of Springfield, Ohio, will act as distributors for the Lister range of diesel engines and particularly the "Freedom" range, Mark F.R. All the engines will be equipped with American accessories upon arrival, to simplify the replacement part problem.

Institution of Naval Architects

AUTUMN MEETING

No. I

THE Autumn meeting of the Institution of Naval Architects, which was held in Italy this year at the invitation of the Associazione Italiana di Tecnica Navale, was officially opened on Friday morning, September 26th, at the Palazzo San Giorgio, Genoa, where the delegates were greeted by Professor Carlo Capacaccia, the Director of the Institute of Technology, Genoa, and Professor Della Ragione, the President of A.T.E.N.A. Speaking in Italian, both professors welcomed the members of the Institution of Naval Architects and expressed the wish that they would enjoy the visit and that the conference would prove a success.

Mr. Leslie Champness, M.B.E., a Vice-President of the Institution of Naval Architects, deputised for Lord Runciman, the President, who was, unfortunately, unwell, and thanked the Italian hosts for the arrangements made and for the hospitality offered to the members. Mr. Champness touched upon the Italian skill and genius in engineering from Leonardo da Vinci onwards and recalled the presentation of a gold medal by Signor Orlando to the Institution in 1913, and also that the Institution had not visited Italy since 1929, so that most of the visitors were meeting the Italian hosts for the first time.

With the conclusion of the formal proceedings, Mr. E. Leslie Champness, M.B.E., M.Sc., was invited to preside during the presentation of the papers.

The first paper read on Friday morning was :—

LONGITUDINAL STRENGTH : A REVIEW OF SOME RECENT DEVELOPMENTS

By JAMES TURNBULL, O.B.E.

SYNOPSIS

Since it had been appreciated that a ship's hull was a large girder carrying a variable load and having a violently fluctuating support, longitudinal strength had been a subject of constant study by naval architects. The "Smith" correction was not often applied and although the standard graphical bending moment calculation had proved satisfactory more information was sought. The serious fractures developed in welded ships led to various investigations and a comparison was made between the tankers "Neverita" (welded) and the "Newcombia" (riveted); no difference was revealed. Similarly, the dry cargo ships "Ocean Vulcan" and the "Clan Alpine" were compared, the former ship making several voyages to record wave data and to measure the effects upon the hull structure.

It was observed that existing wave systems had storm wave patterns superimposed and wave heights associated with length were noted. In the trials, horizontal and vertical bending were often in phase and the stresses became additive on one side of the ship. Stresses due to slamming were measured and slamming was found to increase sagging stresses more than hogging stresses. Tests showed that no significant difference existed in deflection between riveted and welded ships and also that no rivet slip was observed, but riveted construction was capable of adjustment under high stress. Diagrams showed the distribution of longitudinal stresses and a table gave the frequency of stress ranges.

Many structural failures are probably due to poor loading, which in tankers can produce excessive sagging stresses so that correct loading is of paramount importance. Additional experiments are required on ships of varying dimensions and the latest recording equipment should make this possible.

DISCUSSION

Mr. H. E. Steel : The paper could be amplified from experience in order to avoid leaving impressions which I am sure Mr. Turnbull does not wish to convey ; for instance, in two cases of rivet slip in shear-strake butts, they occurred in locally highly stressed areas. Hundreds of fatigue fractures have occurred in all parts of ships' hulls ; it would be curious if they did not, but this statement does not conflict with the data given in the section of the paper headed : "Frequency of Stress Ranges Experienced at Sea." The trouble arises when these normal stress ranges are amplified at flexing areas or by discontinuities and by whipping and vibratory ranges of high frequency superimposed upon them.

We are preoccupied in preventing brittle fractures in welded ships, chiefly because their high rate of propagation is so dangerous. We must eliminate not only the use of steel susceptible to brittle fracture but also as far as is practicable, the sources of such fractures or we may be troubled in both riveted and welded ships with fatigue cracks.

Although fatigue fractures have not in general been considered an important factor in the longitudinal strength of ships, fatigue fractures have caused considerable anxiety, especially in large ships, because of the cost of repairs and of the difficulty in making them effective. There is reason for thinking that satisfactory fatigue strength is of greater significance than increased tensile strength when attempting to provide against fatigue fractures.

Dr.-Ing. Fusini : Starting from the same considerations as Mr. Turnbull, concerning :—hogging stresses in cargo ships with the machinery at the centre, when fully loaded, and sagging stresses when in ballast with deep tanks amidships ; sagging stresses in tank ships when fully loaded; and modern cargo ships with finer hulls than those of the past, I suggest that future cargo ships should have the machinery aft, cargo holds extending from the machinery to the collison bulkhead, double-bottom forward from amidships in order to facilitate ballasting and trimming when loaded, and continuous strong girders connecting all longitudinal coamings of hatchways, to improve the longitudinal strength of the ship.

Mr. J. M. Murray : This paper gives a concise account of the present state of knowledge of the stresses sustained by a cargo ship of about 400ft length. The information contained in it shows that the classical method of carrying out strength calculations initiated by John in 1874 gives reasonably absolute stresses for this type of ship.

The deduction that by using the L/20 wave, without the Smith correction, the theoretical bending moment amidships would approximate to the actual bending moment experienced in severe storm conditions by ships of about 400ft length may perhaps be extended. The bending moment can be divided into two components—that due to the passage of the wave, which depends on the geometric characteristics of the ship and that due to the bending moment in still water, which is a function of the distribution of loading. The effect of the Smith correction is reduced at draughts less than the load draught and therefore at the ballast draught it would appear that, after making allowance for the different geometrical characteristics of the ship at that draught, the wave component of the bending moment will be about the same as the wave component of the load draught.

If this is so then the bending moment calculations may be simplified by adopting the same wave component at all draughts and adding this to the appropriate still water moment.

The statement that the theoretical stresses would be higher in longer ships and lower in shorter ships than those actually experienced needs some qualification. It may be true for ships of the same form and speed/length ratio, but it cannot be applied universally because there is evidence that the effect of speed must be taken into account. In the modern fast cargo liner, which can be driven in heavy weather, the chance of high bending moments occurring is increased. The highest stresses recorded on the "San Francisco" in 1934 occurred when the ship was lying hove to, and had conditions necessitated the ship being driven in that weather, probably even higher stresses would have been recorded.

The diagram showing maximum wave heights for various lengths seems to require justification at the higher lengths, and I would refer to a recent paper in the *Transactions of the American Society of Naval Architects and Marine Engineers* on the motions of ships at sea. A curve, prepared from observations made in the North Pacific Ocean indicates that the ratio of length to height reached a maximum of twelve at 460ft and declined to about twenty at 750ft. At present it is not certain whether the damage to a ship is done by an isolated wave of great magnitude or by a series of waves of slightly smaller size. A wave of the length of the ship does not necessarily induce the most severe conditions, for a static calculation will show that there is little difference when the length of wave is varied from 1 to 1·3 times the length of the ship; therefore, any attempt to relate the chances of excessive stresses to ship length and the most likely length of wave encountered must be treated in a broad sense. I suggest the fitting of statistical strain gauges on ships of various sizes and speeds so that the range of stress induced by the wave could be determined for a variety of types.

The superiority in welded construction of longitudinal framing over transverse framing for bottom and strength deck amidships cannot be too strongly endorsed, and experiments made by Lloyd's Register for the British Shipbuilding Research Association on an element of a double bottom of a ship under compression produced similar stress patterns to those given in the paper.

The shipowner cannot control the elements but he can reduce the possibility of excessively high stresses by careful distribution of the cargo in both oil tankers and cargo ships.

Dr.-Ing. Aniello Nicastro: Too many ships, chiefly tankers, were lost during the last war which, in the first world war would have been saved. I remember the S.S. "Cuma," which sank instantly in the Gulf of Guascogne in 1930. I attribute the losses and the damage suffered at sea to reduced scantlings as well as to local structural deficiencies by reason of which suddenly applied stresses could not be resisted.

With reference to the wave height diagram, I think that the height of the breaking waves in a high sea should be shown separately from that in a calm sea, thus giving a curve lower than that in the diagram.

I believe that rivet slip cannot occur because if it did the riveting would become inefficient and that does not occur in practice. I attribute the failures that occur at discontinuities in the welded ships to the lack of angle connections and of overlaps; both of which provide a mass of material which transfer the stress away from the points of discontinuity and thereby lessen the concentration of the stress at those points.

The differences between the calculated strains and those determined by the bending tests are justified because the shell plating behaves very much as a wire under tensile stress rather than as a rigid plate.

The increase of stress in the bottom shell plating, I think, is caused by the deformation of the transverse structure, and the sea pressure displacing the neutral axis from that determined theoretically. I think it is convenient to determine the "lines of influence" of the ship in her motion over the waves and to study the strength scientifically by calculations based on longitudinal deformation as well as at the points of discontinuity. These calculations are difficult but by making them we shall be able to reduce the losses of ships and of men.

Professor E. V. Telfer: The limited assessment of the stress due to thrust in ships is interesting and a little ambiguous when it is stated that the stress in these particular cases does not exceed half a ton per square inch. That suggests that the stress is of the order of half a ton per square inch. A rough calculation made this morning suggests that the stress due to thrust is quite negligible, of the order of one-hundredth of a ton per square inch. Would the author give us his reasoning in selecting this limit and his method of calculation?

The illustration comparing the distribution of longitudinal stresses for bottom shell plating near amidships infers that the welded ship is much inferior to the riveted, but is the inferiority shown by the welded ships not due to the absence of longitudinal seams in the bottom shell plating? You can have an entirely welded ship, except for the seams at the bottom, which can be either riveted or welded, and we can accept that the development of the riveted ship through the years will then be carried over to the welded ship without having to adopt the longitudinal system of framing.

I think it is excellent that we are now going to see greater concentration on the investigation of the still water bending moment and the correlation of experience for the amount of fluctuation of stress caused by the action of the waves. In the paper it is stated that some years ago the sagging stresses were the most important, whereas now the hogging stresses appear to be the most important and that suggests that it should be possible to have a zero still water bending moment, which could be made one of the conditions of design for all important ships.

Dr. Solda: As it is our purpose to guarantee safety, it will be necessary to improve the quality of steel for welding purposes, particularly if automatic welding is to be widely adopted and no doubt the steelmakers will collaborate.

Regarding the statement that the standard longitudinal bending model calculation is likely to be superseded by a simplified still water bending moment calculation, I think some reservations should be made in order to avoid misunderstanding.

Mr. Turnbull, in his reply, said: Mr. Steel considers that fatigue is an important factor in the behaviour of ships at sea. I believed that not very long ago, but recent tests have convinced me otherwise. I think that very high stress concentration is an important factor.

From the longitudinal bending point of view I think there is something to be said for having the machinery aft and the holds forward, as suggested by Dr. Fusini, provided you fit good ballast tanks amidships. Mr. Murray asked if he could use the same dynamic factor for the ballast draught as for the load draught, and I think that to do so would be as near to the truth as it is possible for us to get at the moment. He also suggests statistical strain gauge tests on a number of types of ships, this is being considered.

In reply to Professor Telfer concerning the stress due to thrust, this figure of ½ ton per square inch was worked out from the measurement of the actual forces on the ship in a certain condition.

I agree with Dr. Solda that the classification societies ensure that we get good steel for welded ships; but that is not sufficient, we have to pay attention to design.

The second paper to be presented was:—

SIX RECENT ATLANTIC LINERS

By Lieut.-General E. De Vito

Synopsis

The liners considered are the "Caronia," "Orcades," "Guilio Cesare," "Andrea Doria," "Independence" and "United States," with some reference to the "Bremen" and "Liberte" and the "America." Statistical comparison is made of displacements and speeds and the linear dimensions in a series of tables, which also set out the hull weights, cubic numbers and the initial transverse stability values. Block coefficients are compared with those derived from Sir Amos Ayre's formula and the question of speed and power examined to establish Admiralty and propulsive coefficients. Tabular statements give the speed and power of the liners and some recent oil tanker geared turbine machinery weights, while the size of the machinery spaces are discussed, together with a note on fuel consumptions. The review of the constructional data shows the degree of evolution represented by the ships, and the limitations placed upon future evolution by physical factors are mentioned. Forebody forms have attained a high degree of perfection, but the afterbody plus appendages is worth further research and the gap between tank self propulsion results and sea trials requires additional technical enquiry. The paper generally discusses sub-division and damage control, increased use of electricity, increased thermal efficiency, equipment items, propeller problems, boilers and propulsion by multi-engines.

Discussion

Dr. Pietro Donati: This paper is of great encouragement to young technicians. I understand the convenience of turbine propulsion for ships requiring high power, but there are many examples of ships of fairly high tonnage propelled by diesel engines.

The saving of fuel when using diesel engines for high-powered ships is remarkable and many descriptions have been published of big ships propelled by diesel engines driving through direct couplings or by a multi-diesel arrangement through hydraulic or electro-magnetic couplings.

One way in which to reduce weight when using diesel engines is to adopt the welded structure, as has been done by many engine constructors.

An arrangement with four engines on two shafts—using hydraulic or electro-magnetic couplings—could produce a fairly high power at a much reduced weight and in a small space. Other advantages would be low consumption of low-grade fuels, high safety factor, for it is possible to exclude temporarily a damaged engine, and low cost.

Thus, the field of high power is for the turbine, whilst for lower powers diesel engine propulsion will co-exist and in some cases compete with the turbine.

Mr. J. M. Murray: In ships of this type each design must be considered on its merits. This is shown clearly by the alterations which were made on the "Europa" before she was put into service as the "Liberte" in 1947. This ship was severely damaged when blown ashore at

Le Havre in 1946 and when repairs were being made radical alterations were made to the design and were described in a paper on "The Refitting of the German Liner 'Europa,'" by J. P. Ricard.

Before the war this ship showed evidence of main structural weakness, cracks having appeared from time to time in the strength deck. After 1939 the ship sailed at 20-22 knots instead of the 26 knots, and therefore the efficiency of the final repairs was not proved. When the ship was reconditioned the structural strength was reinvestigated and calculations showed that the concentration of fresh water in tanks at the end of the ship caused high hogging stresses. It was decided to extend the reinforcement previously fitted on the strength deck, and to alter the distribution of weights in the ship by reducing the quantity of fresh water carried from 4800 tons to 1800 tons by installing evaporators and fitting 2500 tons of solid ballast towards amidships. In this way the stress was reduced by about 20 per cent. Furthermore, by eliminating free surface and lowering the centre of gravity, stability conditions were improved both at the beginning and the end of the voyage. This example is given to show how the main scantlings of these large liners must be related to the internal arrangements.

The fitting of machinery at the after end of the ship is now commonly adopted in cargo ships, and has been adopted in a French passenger ship about 400ft long, where a satisfactory profile has been achieved. This step might induce difficulties in the way of large hogging moments and will need to be considered from this aspect.

Professor E. V. Telfer: From the professorial standpoint, I have found General De Vito's previous work extremely useful in design lectures. I think it would be an excellent idea if we tried to get a paper in our *Transactions* every so often discussing design trends in various types of ships.

In connection with the treatment of weights, General De Vito uses the old cubic number. I think that the cubic number should be replaced by something more in line with modern knowledge of weight similarity. However, I am surprised that the cubic number appears to be so well behaved in this particular case.

In connection with the comparison of model and full size ship results, General De Vito is very emphatic that the model always underestimates the full size ship results. Does this statement refer to the larger passenger ships and to the riveted ships rather than welded ships, because our experience in England is changing very rapidly as we approach the welded ship and leave the riveted ship behind?

With regard to the possibilities of triple screw propulsion being more efficient than quadruple screw propulsion, I think he may be misled by model experiments, because those experiments will favour the central screw because of the high wake shown on the model, but the actual ship will lose much of the centre line wake and will give a less optimistic assessment of the triple screw efficiency.

(To be continued)

INVESTIGATIONS OF ATMOSPHERIC POLLUTION.—Among the papers presented at the recent annual conference of the National Smoke Abatement Society was one entitled "Review of the Fuel Research Station's Investigations of Atmospheric Pollution," by Dr. E. T. Wilkins. In the course of it, Dr. Wilkins said that the instruments in regular use for making various observations concerned with atmospheric pollution now totalled about 1208, of which 110 were maintained by the Fuel Research Board in connection with its programmes, and 1098 by other co-operating bodies. The latter figure, Dr. Wilkins explained, included 453 deposit gauges, 557 sulphur dioxide instruments, and eighty-eight smoke filters.

The Trostre Tinplate Works

No. III—(*Concluded from page 449, October 3rd*)

An important part of the reconstruction project for the South Wales sheet, steel, and tinplate industry is the tinplate plant of the Steel Company of Wales, Ltd., at Trostre, near Llanelly. This plant is now in production and will eventually receive some 7000 tons of hot-rolled coil a week from the Abbey Works for processing into 140,000 boxes of tinplate.

Coil Cleaning and Annealing

AFTER leaving the cold rolling mill the strip is passed through one of two electrolytic cleaning lines to remove all traces of oil prior to annealing. These lines are designed to handle coils up to 38in wide and 72in diameter, and weighing 30,000 lb, and they have a maximum line speed of 2000ft per minute. The coils are transferred to the head of a cleaning line by overhead crane or tractor and placed on the conveyor ramp, to be seen in Fig. 10. From this ramp they are pushed on to the mandrill of a pay-off reel, from which the strip is unwound. As in the case of the initial pickling line, the operation of the cleaning line is continuous, and the leading edge of each coil is sheared off and the coil end welded to the trailing end of the previous coil. Electrical equipment for the line supplied by the Metropolitan-Vickers Electrical Company, Ltd., included the main drive motors and control gear.

The strip first passes through a 22ft long caustic dip washer tank, in which the bulk of the palm oil is removed, and then through a scrubber unit. From this scrubber unit the strip enters the main electrolytic cleaning tank, in which all remaining traces of palm oil are removed. Following the passage through a second scrubber unit, the cleaned strip is finally immersed in a 20ft long hot water rinse tank, from which it passes through wringer rolls and hot air drying sections of the line. At the exit end of the cleaning line, there is a looping pit, which provides for sufficient material for the strips to be sheared off for rewinding in coils of 54in diameter, weighing on average 15,000 lb, ready for annealing.

The pay-off reel at the entry to a line is coupled to a 40kW drag generator and twenty-six 5 h.p. d.c. motors are used to drive the deflector, submerger, wringer and scrubber rolls, whilst a set of master pinch rolls is driven by a 125 h.p. d.c. motor. At the delivery end, tension rolls are coupled to a 100kW drag generator, and the coiling reel is driven by two 75 h.p. d.c. motors in tandem.

All the motors and drag generators are fed from a 250kW d.c. generator, which enables the line speed to be set at any speed required up to 2000ft per minute, by adjustment of the generator voltage. Booster generators connected in series with the motors are provided for automatic speed regulation of the individual units.

Correct tension is automatically maintained in the strip on the entry and delivery sections by "Metadyne" regulators. In the looping pit between the sections, the loop is held at a constant depth by continuously-modulated photo-electric control apparatus, operating in conjunction with electronic and magnetic amplifiers.

Control of the cleaning line is effected from two desks situated one at each end of the line. Mounted on an annunciator desk adjacent to each control desk are mounted signal lamps giving visible indication of the condition of the various auxiliary drives, and push-button controls for starting and stopping these units. The main contactor control boards, motor generator sets, amplifiers and other control apparatus for the electrical equipment are situated in the basement below the lines.

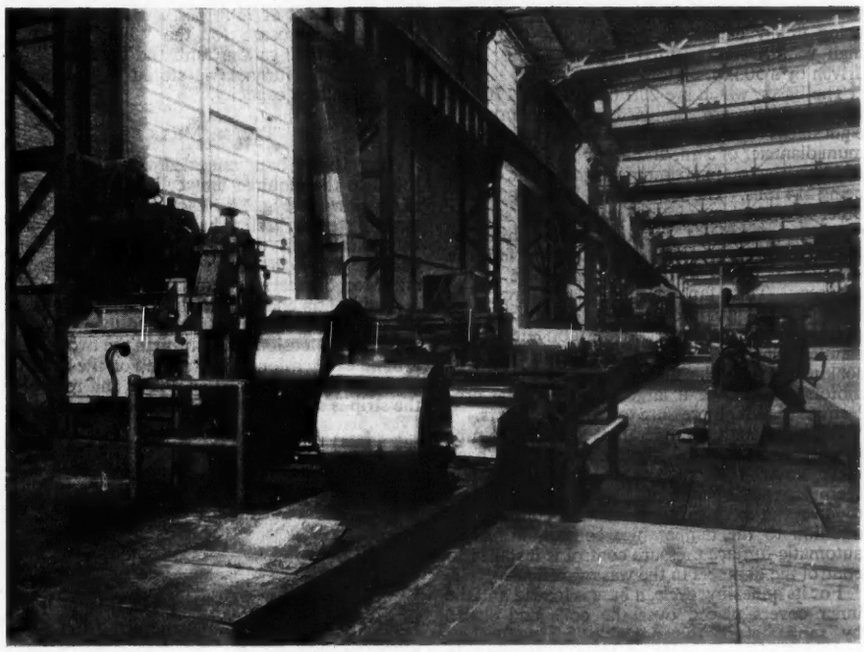

Fig. 10—Entry End of Cleaning Line

From the cleaning lines the coils are conveyed by fork truck to the annealing section where, by heat-treatment, the grain structure is re-crystallised and the stresses set up in the cold mill are relieved. This annealing plant, which was installed by the Salem Engineering Company, Ltd., of Milford, near Derby, and comprises five portable cover furnaces and twelve bases, can be seen in the photograph we reproduce in Fig. 11.

The furnaces, which are 22ft long by 12ft 8in wide inside, are direct-fired and are each equipped with thirty air atomised oil burners, fourteen on each side and one at each end. The products of combustion are vented from the furnace by means of three exhaust ports situated in the bases.

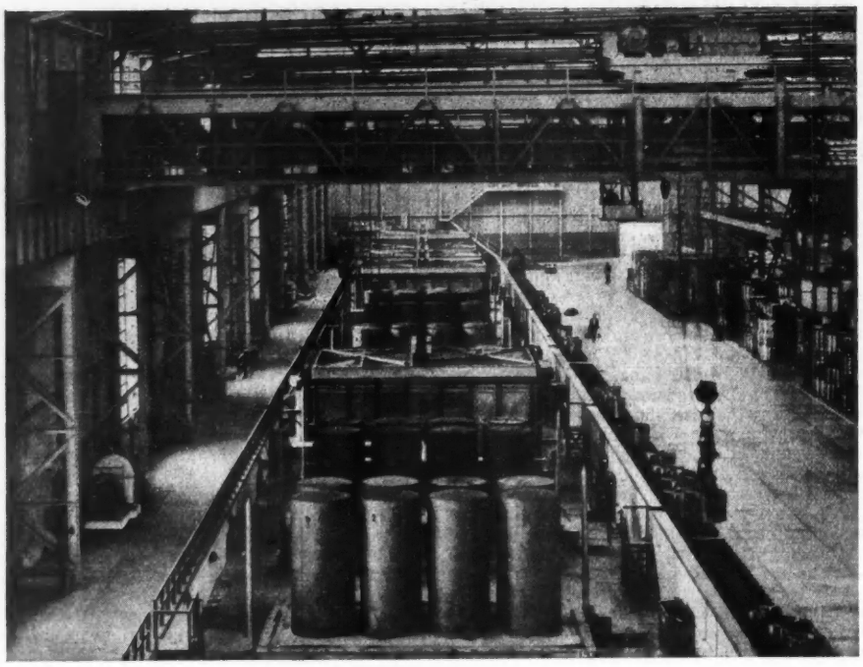

Fig. 11—Annealing Furnaces

These ports conduct the waste gases to flues in the basement and thence to a main flue, the gases being finally exhausted by either of two 75ft-high venturi stacks, fitted with an ejector fan-driven by a 50 h.p. motor.

The bases, which are 28ft 6in long by 17ft 6in wide overall, are designed to accommodate eight stacks of four coils. The coils having a maximum diameter of 54in, and are loaded to a height of 132in, the total maximum weight of one charge being 214 tons. The coils are separated from each other by ribbed convector plates and are stacked upon hearth plates mounted upon diffusers. Below each stack of coils is mounted a fan, the impeller of which revolves in the centre of the diffuser. This fan circulates the protective inert "NX" gas around the coils, which are enclosed with an inner cover fabricated from stainless alloy steel sheet during the heating and soaking cycle. The fans are driven by 15 h.p. motors and deliver a large volume of the protective gas at high pressure to the inner covers.

Fully-automatic temperature control is provided by means of thermocouples in each inner cover and the cover furnace. These thermocouples operate oil and air control valves to give the necessary pyrometric control. In addition to the temperature control, means of automatic furnace pressure control is installed to control the dampers in the waste gas flues.

For its annealing cycle, a base is loaded and the inner covers placed over the coils and sealed by sand before the portable cover furnace, weighing approximately 50 tons, is lowered on to the base. Upon completion of the firing period the cover furnace is lifted and lowered on to a fresh base which has been previously loaded with coils. The coils which have been annealed are allowed to cool, and when their temperature reaches about 280 deg. Fah., the inner covers are removed and the coils taken away to finish cooling before temper rolling.

The plant for generating the protective atmosphere is housed in a building outside the annealing bay, and comprises three units, each capable of generating 12,000 cubic feet of "NX" gas per hour. A typical analysis of this gas is as follows: nitrogen, 97 per cent; hydrogen, 1·2 per cent; carbon monoxide, 1·5 per cent, with traces of methane and CO_2.

In these generating units the gas is generated from kerosene which is burnt without excess air in specially-designed oil to gas generators. The products of combustion are subsequently washed with monoethanolamine to remove carbon dioxide and sulphur, and then passed through refrigerators and alumina dryers to remove moisture. The "NX" gas is delivered by compressors at 75 lb per square inch to two receivers. Kerosene for the "NX" plant is stored in a 1000 gallons tank and the fuel oil for the annealing furnaces is stored in a tank of 135,000 gallons capacity.

Temper Mills

After it has been annealed the strip is cold-rolled to the required temper in the two temper mills shown in Fig. 12. Each of these two-stand tandem temper mills has 18in diameter 48in wide work rolls with 53in diameter 47in long back-up rolls, carried on tapered roller bearings and Morgoil bearings respectively.

At the entry end of the temper mills the coils are placed on a drum pay-off reel and then threaded round entry tension rolls, through the two stands, around exit tension rolls and then on the mandrel of a rewinding reel. After rolling and re-coiling the strip is stripped off on to a conveyor, whence it is taken either to stock or direct to the "cut-up" or "preparatory" lines. At this stage, the coiled strip which is to be hot dipped, is passed on for side trimming and cutting to size, and that which is required for electrolytic tinning is passed to a preparatory line, where the off-gauge is removed, the edges side-trimmed, and the strip re-coiled to ensure a good condition for the continuous electrolytic tinning operation.

All the electrical equipment for the two two-stand tandem temper mills was designed and supplied by the General Electric Company, Ltd. Each stand is driven by a 1000 h.p. motor which, together with the driving motors of the tension rolls, is supplied from the main 2000kW motor generator set. The uncoiler and reeler motors receive power from an auxiliary motor generator comprising a 500 h.p. synchronous motor coupled to two 250kW generators. For the excitation of the various machines a separate motor-generator set is provided which consists of a 120 h.p. squirrel cage motor driving four exciters—two for the driving motors of the main and auxiliary motor generator sets, a third for supplying constant voltage excitation and the fourth for main control excitation. A booster set is also installed for the stand and tension roll motors.

The mills are contactor controlled, operation being from control cabinets mounted on the mill stands. The time taken to accelerate the mill from rest to full speed can be varied from twelve to twenty seconds, and for stopping the mill from full speed, five to twenty seconds. Mill speed is varied by voltage variation of the generators affected through cascade exciter control; operation of the "thread" or "run" buttons on the control cabinet causes the mill speed to change to that selected. A "hold" button maintains the mill speed at any intermediate values; a "stand-speed-up" button causes a slight increase in the speed of the second stand which returns to its preset value immediately the button is released.

Automatic control of the tension between the stands is obtained by a tensiometer roll which provides the correcting signal to an electronic amplifier from which two of the fields of the cascade exciter for the first stand drive are energised. Provision is also made for manual control of the strip tension between the two stands.

Coil Preparation

As already mentioned, the coils intended for hot dip tinning are taken to a cutting up line, and here they are placed by an overhead crane or a tractor on to a pay-off reel. From this reel the strip is fed through a looping pit into a side

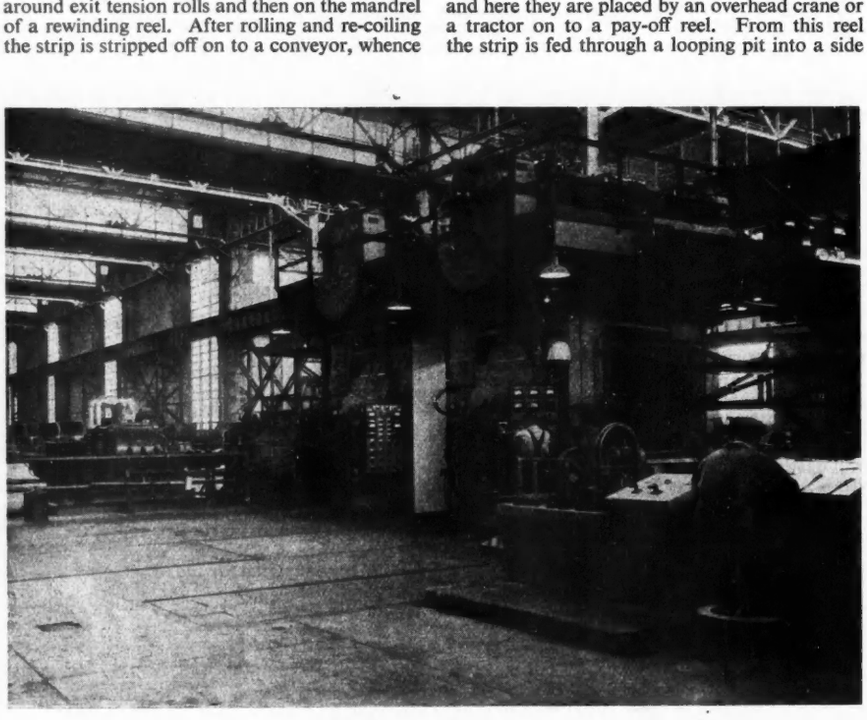

Fig. 12—Temper Mills

trimmer. The rotary knives of this side trimmer are adjustable between 14in and 38in, and the sheared scrap they produce drops through a chute into the basement, where it is collected and returned to the steel works. The trimmed strip passes on through a second looping pit and on through levelling rollers before being cut up into sheets by rotary shears.

In the looping pits between the uncoiler and the trimmer and also between the trimmer and the shear, the length of the loops is automatically held constant by photo-electric apparatus, which controls the speed of the motors through electronic and magnetic amplifiers. Off-gauge and pinholed sheets are detected and automatically separated from the prime sheets, the good and bad sheets being carried on conveyors for separate piling. The piler lifts on which the sheets are stacked are arranged for automatic lowering as the sheets arrive off the conveyors.

Electro-magnets situated under the conveyor belts serve to guide the sheets and hold them straight, and groups of magnets can be switched in according to operating conditions.

All the motors on each line are supplied from a Metropolitan-Vickers 150kW variable voltage generator, which enables the line to be set to any required speed up to 1000ft per minute.

The hot dip tinning equipment has not yet been installed at Trostre, and the plates are, for the present, being taken to the older plants in the area for this process. In a few months, nine Poole Davis hot dip tinning machines will be placed in service.

Coils are prepared for electrolytic tinning in one of two lines, where the off-gauge at the ends of the coils is sheared out, the sides are trimmed, and the leading edge of the coil is welded to the trailing edge of the preceding coil to form coils of up to 30,000 lb. In these lines the side trimming unit, shears and welder are situated between two looping pits and the maximum speed of the line is 1800ft per minute.

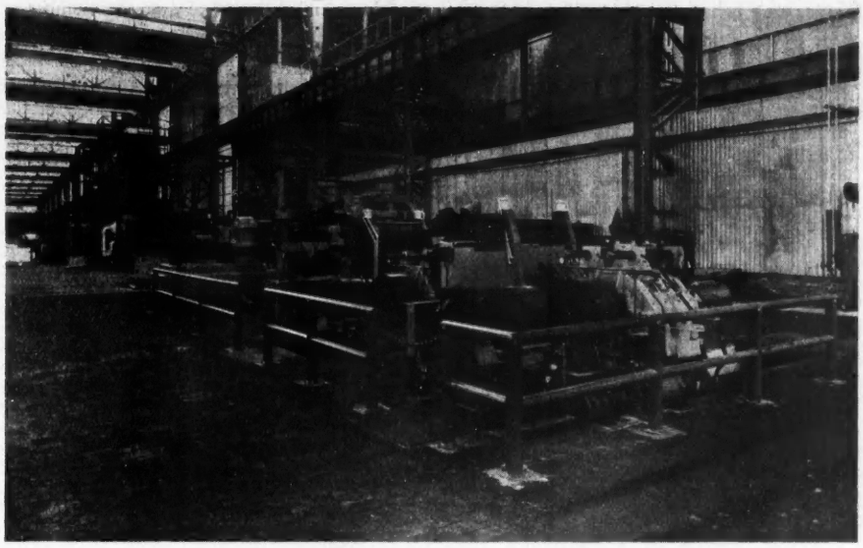

Fig. 15—Entry End of Electrolytic Tinning Line

Electrolytic Tinning

The electrolytic continuous tinning unit consists of two acid "Ferrostan" lines, designed to handle 30,000 lb coils and tin ½ lb coatings at a speed of 800ft per minute. At the entry end of the line to be seen in Fig. 15, two uncoilers have been installed to make continuous operation possible. A 70ft deep looping pit is used to provide a reserve of material for continuous working, whilst the leading end of one coil is sheared and welded to the trailing end of the preceding coil. A photo-electric cell installation controls the loop position in the pit.

The strip first passes through the cleaning zone of the unit where, after being electrolytically degreased, it is rinsed with cold water and undergoes electrolytic sulphuric acid pickling before being finally sprayed with water and brushed. In the following tinning zone there are five plating tanks and a drag-out tank where the strip is washed and the electrolyte recovered for future use. The strip then enters a flow-melt unit where it is heated to cause the tin to flow on the surface to improve the quality and impart a bright appearance. In the subsequent electro-chemical chromic acid unit, the tinned sheet is treated to prevent discoloration on lacquering and whilst it is stocked. A very fine emulsion of cotton seed oil is then applied to the strip to give the necessary lubrication for subsequent fabricating operations.

The strip passes through "pin-hole" and "off-gauge" detectors for automatic ejection at the exit end of the line, where it is finally sheared into plates of the required width and classified by visual inspection. The plates are automatically counted and spaced ready for packing and removal to stock.

A metal rectifier installation, designed and manufactured by the Electric Construction Company, provides the following supplies for the various stages of the electrolytic tinning line: alkali cleaning, 6000A at 16V; pickling, 6000A at 16V; plating, 60,000A at 16V. There is also a tin recovery plant, with an output of 3000A at 16V, for both lines.

In the simplified single line block diagram (Fig. 16) we show the basic layout of one of the two 60,000A tinning lines, and the associated cleaning and pickling plants; the tin recovery plant is, of course, common to both tinning lines. Each line has ten plating circuits, each of which is supplied from a bank of six rectifiers and one transformer, having an output of 6000A at 16V. The positive of the rectifiers is connected to the anodes and the negative is connected to the rolls over which the strip is passing. The strip is uncoiled from the rolls and fed through the plant as shown by the arrows. It is drawn through the pinch rolls and the process current is carried by busbars from the rectifiers to anodes in each tank. Thence the current returns, through the ionised solution and the strip, to the rolls and then to the negative side of the supply.

The current in each of the ten circuits is independently "trimmed" to give the best conditions for plating by passing the feed to each transformer through an oil-immersed, vertical spindle induction regulator capable of varying the output voltage by 25 per cent.

The whole plating supply is fed through four large oil-immersed, vertical spindle induction regulators, mechanically coupled together and working in parallel.

By supplying the driving motor through automatic control circuits, it is ensured that the output of the rectifier as a whole is always proportional to the speed of the strip and the deposit of tin per square foot is kept constant. The induction regulators provide control of the output voltage between 16V and 1·6V.

The alkali cleaning and pickling currents are derived each from a transformer and six rectifier tanks fed through an oil-immersed, vertical spindle induction regulator, which controls the output of the rectifiers by variation of a.c. input. Similarly, the tin recovery plant consists of three rectifier tanks and one transformer, with an induction regulator.

The basic sub-unit making up the installation is the individual oil-immersed, selenium metal

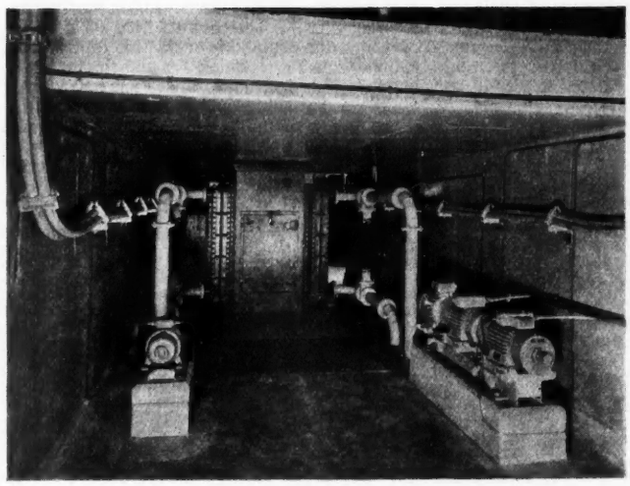

Fig. 13—Air Cooler for Motor Generator Set

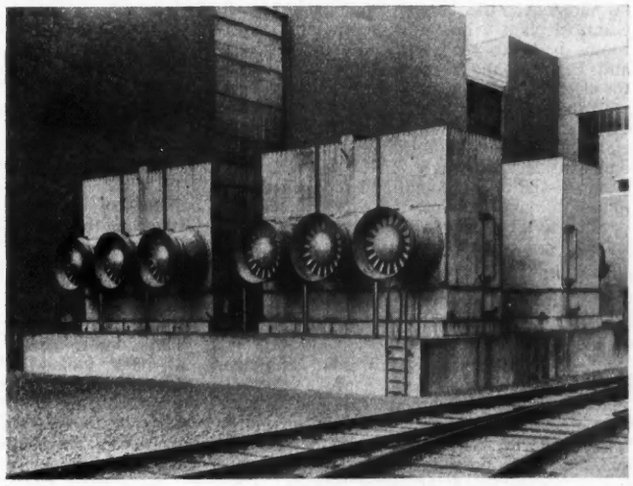

Fig. 14—Water Coolers for the Palm Oil Recovery Plant

rectifier tank, which is capable of an output of 16V, 1000A. The connections in each tank are three-phase bridge, and the required number of tanks are grouped together and fed from a single transformer to give the required output. All rectifier tanks and transformer tanks are water-cooled to conserve space and to reduce the ventilating problem. The cooling consists of copper coils in the top oil of both rectifier and transformer tanks, through which the cold water is circulated continuously. Water failure alarms are included in the control circuits. In the oil at the top of every rectifier tank a thermal switch is fitted to give alarm and indication of excessive temperature. Protection is also provided in the supply to each rectifier transformer in two stages; an excessive load lights alarm lamps, a heavier fault trips the main circuit-breaker and stops the line.

Contactors are used to control the a.c. supply to each rectifier transformer, but they do not clear faults, which are referred back to the main circuit-breaker, thus shutting off the complete plating current supply. A fault on any particular section results in the contactor for that section remaining open when the main circuit-breaker is restored. The faulty section is therefore isolated until the reason for the fault can be discovered.

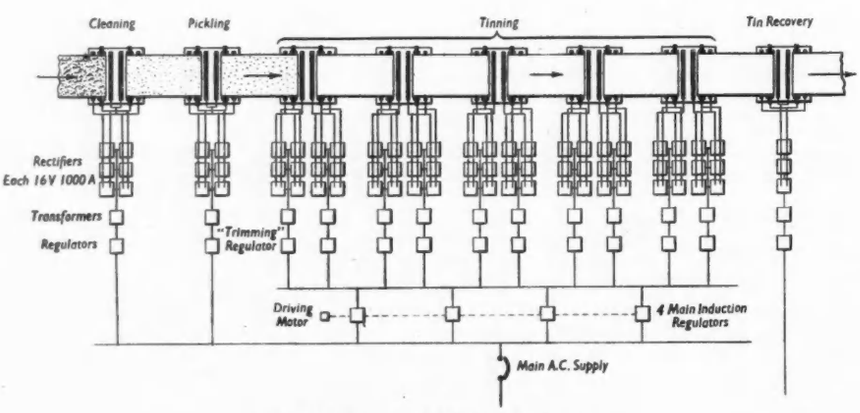

Fig. 16—Diagram of Tinning Line Layout

Line interlocks are included to relate the operation of the cleaning and pickling plants to that of the main plating plant for correct sequence of operation. All auxiliaries and contactors are supplied from a separate 230V direct current source provided by a rectifier.

The firm particularly concerned in the supply of the air cooling and water cooling equipment for the motors and auxiliary equipment for the five-stand cold mill and the two-stand temper mills, together with the water coolers for the recirculating and cooling system for the five-stand mill rolls was Heenan and Froude, Ltd., of Worcester, the cooling equipment for the electrical plant drive motor rooms and control rooms being to the specification of McLellan and Partners, the consulting engineers for all the electrical plant at the Trostre works.

In the air-cooling plant for the five-stand mill drive motors, the exclusion of dirt from the electrical plant was of the utmost importance and consideration was given to two alternative systems—the once-through and the recirculating and recooling systems. It was eventually decided to use a recirculating system with water tube air coolers, as even with the more efficient filters that would be necessary with the once-through system, the full quantity of air needed for machine cooling would give a far greater hourly weight of dust and dirt than with the closed circuit system, in which the air filtration was confined to the comparatively small amount of make-up air. The easy maintenance of the smaller and simpler filter that could be used with the recirculating system was another advantage. The basement, already provided for structural reasons, made possible a convenient layout of the air coolers below the motor room.

The first schemes put forward were based on large units sharing the total duty; but the final decision went in favour of a greater number of smaller units.

All mill motor and generator armatures are provided individually with ventilating fans, whereby cool air is drawn from a plenum in the basement; the air enters each machine at the driving end and leaves it at the commutator end, whence it returns through the coolers to the basement. The synchronous motors of the motor generator sets are self-ventilating, with fan blades mounted on the rotors and, if necessary, they can work with open ventilation, with their individual air coolers out of action. The other electrical machines are provided with individual motor-driven fans.

It was estimated that some 10 per cent of ventilating air for the motors and generators might leak or spill from the carcases. The commutators are open to the motor room in order to provide easy access to the brushgear and to allow the carbon dust from the brushes to be carried away by the leakage air and not foul the recirculating system. This 10 per cent of make-up air is delivered to the basement through wet air filters, supplied by Matthews and Yates, Ltd., as part of a sub-contract to Heenan and Froude, Ltd., for the air filtering and ventilating equipment of the motor room electrical drive and control room.

In the motor-generator sets, the heated air from each electrical carcase is discharged through its individual air cooler into the basement, which acts as a reservoir of cool air for recirculation to the various armatures by their individual fans. One of these air coolers in the basement is shown in Fig. 13.

For the five-stand mill drive motors, eight air coolers are arranged against openings in the side wall of a common concrete corridor or air-duct in the basement; separate fans draw the cooled air from the basement, each armature again having its own motor-driven fan. The coolers are in staggered formation on each face of the side wall alternately, giving the necessary space between the coolers for rodding out the tube bores during maintenance operations; the total cooler capacity is sufficient for one cooler to be out of service even during full load.

For the temper mill drives, the main contractor was Matthews and Yates, Ltd., and Heenan and Froude, Ltd., sub-contracted for the air coolers.

The table given below shows that the total heat to be removed from the cooling air of the five-stand motors and their auxiliaries was calculated to be some 2400kW. The consumption of mains water to carry away this heat would have been excessive and the air coolers were therefore designed to be served with recirculated water cooled in evaporative water coolers. These coolers are Heenan "P" forced-draught all-metal units—the total duty being spread over three identical units disposed on the roof of the control room. This arrangement reduced the water consumption from 2805 gallons per minute required by the coolers, to about 25 gallons per minute, a saving of over 99 per cent.

As already mentioned, the rolls of the five-stand mill are cooled by a solution of palm oil in water and Heenan "P" water coolers used in this recirculation system are designed to dissipate 16,800,000 B.Th.U.s per hour. The group of "P" coolers serving the palm oil recovery plant is shown in Fig. 14. As is well known, this oil, used with water for cooling mill rolls, is sufficiently costly to make recovery plant worth while. Below a certain temperature palm oil takes a semi-solid form, and for this reason, the coolers had to be provided internally with steam jets for the periodical removal of the semi-solid deposit of oil from the cooling surfaces. This deposit, after warming up, can then be recovered in the settling tanks in the ordinary way.

Air and Water Cooling Data

Plant	Air coolers		Water coolers
	Heat dissipation, kW	Net air volume, cubic foot per minute	Water flow, gallons per minute
Five-stand mill :			
Drive motors	964	114,930	1120
M.G. sets, &c.	1408	147,700	1685
Temper mills :			
Drive motors	218	19,800	—
M.G. sets	450	42,000	—
Total	3040	324,430	2805

For plant servicing and maintenance purposes, a large machine shop has been laid down in a central position within the main building of the works. A special maintenance section equipped with roll grinders, a roll lathe, &c., provides service for the mill rolls, which are conveyed to the department on electrically-driven transfer cars.

It will be appreciated from our description of the progress of the coils of strip from unit to unit through the works a particularly comprehensive system of cranes has been installed. Six of the heaviest of these cranes, two in the mill bay, two in the annealing bay and one in the roll shop, were supplied by Sir William Arrol and Co., Ltd., of Glasgow, and are of 112ft span. Each of these cranes is designed to lift 50 tons on the main hoist and 10 tons on the auxiliary hoist. The same company also supplied a 45-ton electrically-propelled roll transfer bogie. Other electric overhead cranes used in the works were made by Joseph Booth and Brothers, of Rodley.

To supply the large amount of steam for processing purposes, and high-pressure hot water for heating the buildings, a large boiler house adjoining the main building was built and equipped by Danks of Netherton, Ltd., of Netherton, Dudley. In this steel-framed, brick-panelled boiler house, ten "Super Economic" boilers, 11ft diameter, 18ft long over the tube-plates, and suitable for a working pressure of 150 lb per square inch, have been installed.

These boilers are arranged in two banks, with a central firing aisle, each boiler being equipped with mechanical stokers, forced and induced draught fans, downflow grit arresters and soot blowers. An independently fired superheater for working in conjunction with the boilers has also been installed.

Two bulk acid storage installations were supplied by L. A. Mitchell, Ltd., of Manchester. One of these installations, for supplying the pickling lines, is designed to hold 98 per cent concentration sulphuric acid in four 12,000 gallon tanks; the other, for the tinning lines, has a single 12,000 gallon tank. The bulk storage tanks are elevated for gravity feed to a measuring vessel and subsequent discharge to the lines. They are filled by pumping from rail tank wagons and their contents are registered on a calibrated gauge board through a float and indicator unit.

METAL FIXING ASSOCIATION.—The formation of a new association has been announced by the owners of the various systems for fixing insulating linings in buildings with metal components. The new body, which is called the Metal Fixing Association, includes in its objects the defining of minimum standards of materials and workmanship. The first Code of Practice on this subject is expected to be published shortly. In addition, the Association will be concerned with the promotion of the industry; the collation and dissemination of statistical and other information; legislation; and negotiations with other recognised bodies in the architectural, building, engineering and allied professions and with Government and local authorities. The Association, however, has no intention of being concerned with price maintenance. It is stated that membership will be open to all firms which maintain a full-time metal fixing department with direct employment of labour. Its address is 32, Queen Anne Street, Cavendish Square, W.1 (Langham 7616).

Resignalling at Euston

Major resignalling work at Euston, in connection with the £300,000 scheme for improving traffic facilities at the station, has now reached an important stage. On Sunday, October 5th, the new signal box was brought into service. This article describes the new signal box, signal and points operation, &c.

THE signalling scheme here described provides in its entirety for the lengthening of six platforms, including those serving the principal arrival lines, Nos. 1, 2 and 3. Originally the old "Euston No. 2" manually-operated signal box constituted a major obstacle. It was one of the largest on British Railways, having a total of 288 levers, and as shown in Figs. 2 and 3, the locking frame was in two sections, one against each side wall, with such interlocking as was necessary between the two sections actuated by rodding passing beneath the floor. As such, the box occupied a considerable area close to the platform ends, and lengthening of the platforms, together with improvements in track layout, could not be carried out until the box had been removed. Modern signalling practice, including the use of complete track circuiting and illuminated diagrams, makes it unnecessary for the signalmen to see all train movements, and the new signalbox has been erected on the east side of the line, on the Camden side of the second overbridge that crosses the railway in the immediate approach to the station. Now that this new signalbox has been brought into service, work can proceed with the platform lengthening and track layout changes, but it will be appreciated that some of the signalling at present controlled from the new box is of a temporary nature, and will be finalised only as the civil engineering work proceeds, stage by stage.

The signalling, which was dispensed with on Sunday, October 5th, had remained virtually unchanged since the Euston-Camden widening scheme of 1905. Many additional safeguards to operation had been added in the intervening years, but the equipment was due for major replacement and modernisation. The mechanical locking frame in Euston No. 2 box was of the well-known London and North-Western "tumbler" type, designed by the famous chief mechanical engineer of Victorian days, Francis W. Webb. The locking frames in some of the smaller boxes were of the "Crewe" all-electric type, operating the "Crewe" type of electric point machine and electric semaphore signals. Examples of the characteristic L. and N.W.R. semaphore can be seen in Fig. 1, where one of the new welded colour light signals structures, under construction, is shown in the background. The approaches to Euston, of which a very good general impression can be obtained from the track diagram seen above the new locking frame in Fig. 4, includes a comprehensive system of flying junctions that enables light engine and empty stock movements, both into and out of the station, to be kept clear of the four running lines. This facility, which formed part of the 1905 widening scheme, is of great importance, seeing that during an average weekday, over seventy main line and local steam trains, and approximately the same number of electric suburban trains depart from Euston. An equal number of trains arrive at the station during the same period. When the scheme of platform lengthening and track remodelling is complete, it is anticipated that considerable benefits in train operation will be realised, and delays at present experienced, which on the arrival side are partly due to long trains extending beyond the existing platform ends and fouling tracks connecting to other platforms, will be largely eliminated.

The New Signalling Scheme

One all-powered signalbox, with a 227-lever Westinghouse frame, having all-electric lever interlocking, replaces three existing signalboxes, while a fourth box, though retained, will no longer be required to deal with main-line traffic. The levers in the new frame operate on the "individual function" basis, each signal and each pair of points requiring separate lever movements to operate them. The new signalbox, a strikingly handsome modern building, was designed by the architects office of the civil engineer's department. It is constructed with load-bearing brick walls, and reinforced concrete floors and roof. Windows extend for the full length of the operating floor and give a long uninterrupted view of the line up the heavy gradient towards Camden. The building contractors for the signalbox were Messrs. Tersons, and it was completed after eight months' work. The locking frame is in one section, and duplicate illuminated diagrams are provided, as shown in Fig. 4. The frame itself contains sixty-one point levers (including two ground frame releases), 126 signal levers (including fifty levers for ground signals and five for controls to Euston carriage sidings signalbox) and forty spare levers, thus providing ample cover for any future extensions.

The main running signals are all of long-range, multi-aspect, colour-light design, working in some cases, with route indicators of the theatre sign principle, while in conformity with general practice on British Railways to-day, the position light signal is used for subsidiaries and ground shunts. Where subsidiary signals are used for calling-on purposes, an illuminated letter "C" is used in addition. There are also twenty-one instances of movements provided for leading from running signals with sidings that are not track circuited; for these, short-range single-aspect yellow light units are installed. In all there are thirty-two long-range colour-light signals; twenty-six position-light subsidiary signals; twenty-one short-range yellow light units; thirty-five position-light ground signals. All shunt movements are now controlled by signal indication. On certain of the ground shunt signals, stencil letter indicators have been provided in addition, for the special purpose of distinguishing any of the routes available at such a ground signal which gives an appreciably shorter run than the remainder.

The ground signals provided on the arrival side of the station, to cover shunting movements, must, of necessity, be passed by running movements in the facing direction. Operation of the incoming main line signal lever automatically clears such ground signals as will be passed, but they are replaced to danger one by one, as each portion of the route ahead of the signal is released by the passage of the train. Route locking on the sectional release principle is used. If, after the signalling of a main line movement, it should be necessary in emergency to set one of the ground signals on the route to danger, this can be done by putting the individual lever for that signal to the clear position and then replacing it to danger. The platform departure signals are provided with position-light subsidiary units, which are also used for shunting purposes, including additional wrong-road shunts to the two up lines. Back indicators showing the word "off," and stencil letters for the route indication, have been generally installed on these signals to signal the departure of long trains which overhang the platforms, and the word "off" is also repeated at the head of the platform for the benefit of the guard and the driver on any banking engine. The running signal levers are locked in the normal position unless all the points are set and the required track circuits are clear; these locks cover the replacement of the signal stick relays in lieu of backlocks. Signal levers are also approach locked. The ground signals are free of track circuit control, except for those track circuits required to prove clearances, and are locked norma unless the points are correctly detected. They are generally approach locked, and many also have back locks, in order to complete the holding of the route. The ground signals are not replaced to danger by track circuit, when used individually, but are solely under the control of the lever.

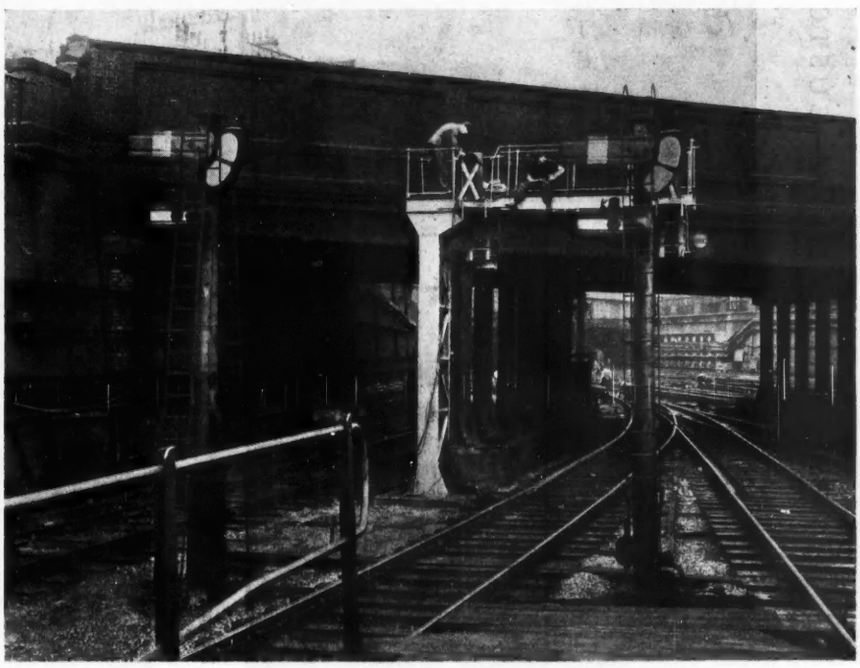

Fig. 1—Old and New Signals

Electro-Pneumatic Point Operation

The sixty-one point levers, previously mentioned, control ninety-four electro-pneumatic point mechanisms. The operating cylinder, escapement crank, bolt and detector are usually combined on a single bedplate and placed in the 6ft way. The control valves are of Westinghouse "CP" design, in which air is supplied to the normal or reverse magnet, as the case may be, through the agency of a third, or lock, magnet; the air supply is cut off as soon as the points have been detected in their new position. The

Fig. 2—Old Euston No. 2 Signal Box

Fig. 3—Old Euston No. 2 Signal Box—Interior

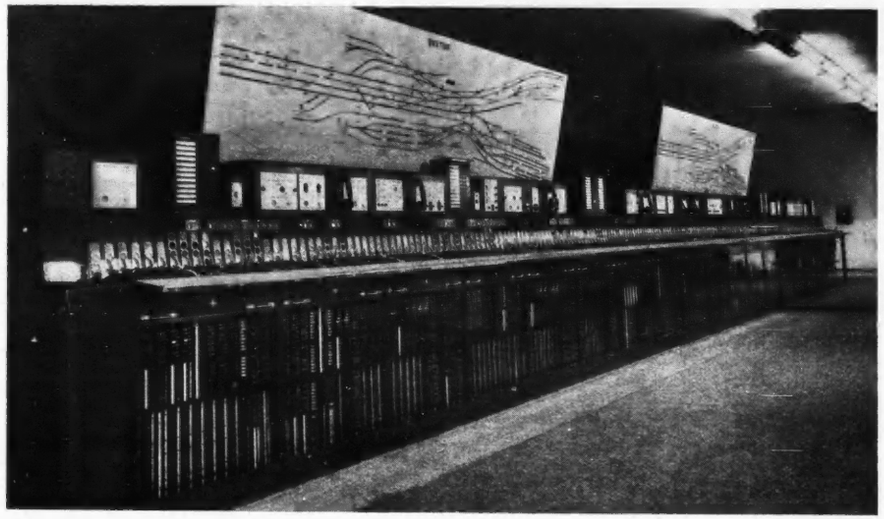

Fig. 4—New All-Electric Lever Frame—Before Completion

Fig. 5—New Signal Box at Euston

air supply is at 50 lb per square inch. Each point lever is electrically locked by the track circuits immediately covering it ; it is also locked on the sectional release principle, by one or other of the route stick relays. These latter are de-energised when the lever of a signal reading through the points in question is pulled ; they are energised once again by the clearance of the appropriate track circuit. There are no normal and reverse indication locks on the point levers. Resulting from this arrangement signalmen have no need to wait for the indication to be received before lever strokes are completed, and the setting up of a route involving a succession of switch movements can be made very quickly. The lie of each pair of points is indicated by the display of an illuminated letter, "N" or "R," behind each point lever.

Special Signalling Arrangements

Many trains leaving Euston are provided with banking assistance up the incline to Camden, while on the arrival side, the train engine usually remains coupled while the empty stock is drawn out and proceeds via one of the carriage lines. Signals covering such movements are arranged to be replaced to danger after the last wheel has passed over the controlling track circuit, so that the bank engine, or propelling engine, receives the same signal indication as that observed by the engine at the leading end of the train. On the arrival side incoming running signals are replaced directly by a track circuit ahead ; this arrangement has been chosen so that both engines on double-headed trains may pass this signal before it is returned to red.

A green aspect is displayed if a platform line is clear to the buffer stops, otherwise a calling-on aspect is selected under an arrangement designed to safeguard against a signalman inadvertently attempting to turn a normal length into a platform that is already occupied. In each platform a separate track circuit is provided from the buffer stops and of such length to accommodate vehicles which are normally required to stand there at certain times of the day. If any further portion of the platform is occupied, the calling-on signal giving acceptance to the platform is cleared only in special circumstances. Working in conjunction with the incoming signal is a short berth track circuit ranging, in the different locations, from 50 to 70 yards long. The calling-on signal can be cleared only if the incoming movement is completely accommodated on this berth track circuit, and the track circuit on the approach side of the berth track is clear. Due to the short length of these berth tracks, the "movement" awaiting entry to the platform cannot be more than a single locomotive, or a locomotive and one or two vehicles ; thus, the chance of a signalman turning a full-length train into a partially-occupied platform is eliminated. Similar arrangements govern the movement of empty stock trains into departure platforms. An exception is made to the practice of giving calling-on aspects only in the case of platform No. 5, in which mail vans are berthed for lengthy periods at the head end. In order not to delay the electric suburban trains that use this platform, a red aspect has been provided to protect the vans, and a yellow aspect is displayed on the incoming signal to give entry to the platform.

Track Circuits, Signal Locations, Cabling

The track circuits are of the a.c. condenser-fed design, and as many as possible of the relays, feed sets and so on are housed in the new signalbox. In all, 127 track circuit indications appear on the illuminated diagram, which as previously mentioned, is in duplicate. The diagrams themselves are of the kind developed by the London Midland Region, to which particular reference was made in THE ENGINEER for June 6, 1952, in connection with our description of the Marshalling Yard at Toton. The diagrams are printed by a true-to-scale process direct from the master drawing on to a sheet of white plastic material 0·020in thick. The track circuit at the head of platform No. 5 referred to in the previous paragraph, takes the form of an axle-counter section, as vehicles stand on this portion of line for so long that a track circuit of the normal type would be unreliable. Apparatus including cable terminations, which could not be conveniently located in the new signalbox, is installed outside at various locations, there being a total of fifty-seven steel location cases, and about 400 core miles of O.I.L.P.C. cable have been provided to link these locations and the signals and points with the relay room. Most of this cable is plain served, run on continuous timber supports, with occasional expansion gaps. Armoured cable has been found necessary for some sections and this is run on metal brackets. Ground routes for cables are provided in timber trunking, and 100 miles of single core cable have been used to wire up to the individual functions outside.

Fig. 6—Electro-pneumatic Double Slip Point Layout

Signalbox Equipment

The relay room contains 960 relays, each having detachable terminal boards. These permit the quick removal of a relay mechanism, for routine examination or any other purpose, without disconnecting any wires. In the wiring of the relay room and the 227-lever locking frame, 72 miles of single core cable have been used.

Ordinary block working has been abolished on the four running lines, and train describers of the storage type are now used. These describers, and other apparatus such as signal telephones, are mounted on the top shelf of the locking frame above the signal and point indication panel. They can be seen in the photograph of the new locking frame reproduced in Fig. 4. A teleprinter for train reporting, and concentrators for ordinary telephone circuits, with selective calling, have been provided in the new signalbox. An emergency telephone circuit has been provided between the locking frame, the relay room, and outside locations, for use of the linesmen. There is also loudspeaker communication between the locking frame and the station inspectors on both arrival and departure sides.

Power Supplies

Power will normally be supplied by the B.E.A. over a four-wire three-phase cable to a substation which is adjacent to but not actually part of the main signalbox structure. An emergency supply is automatically available from a 60kW diesel generator set, with facilities for synchronising with the normal supply.

Earth leakage indicators and a fire contactor have been provided.

A supply of air at 50 lb per square inch for the points is obtained from either of two electrically-driven air compressors, with an additional diesel-driven compressor as an automatic emergency standby.

Train Service Alterations

During the period from October 5th to November 9th, when platform extensions and track alterations will be made, some amendment and curtailment of the regular train services are necessary. On weekdays, these alterations involve the retiming of certain trains, so as to relieve the pressure on the arrival side at busy periods ; the 2.20 p.m. express from Manchester, for example, is due at 6.20 p.m. instead of 6.12 p.m., and the 12.45 p.m. from Bangor at 6.45 p.m. instead of 6.28 p.m. The succession of arrivals during the transition period will thus be 6 p.m. (the "Royal Scot"), 6.20 p.m. and 6.45 p.m., instead of the normal 6 p.m., 6.12 p.m., 6.28 p.m. and 6.40 p.m. The last-mentioned train is cancelled altogether. The majority of inward-bound sleeping car trains will be diverted from Euston altogether. In general, south-bound Scotch sleeping car expresses will be run into St. Pancras, and other trains will have the sleeping cars detached at Willesden. On Sundays, a number of long-distance expresses from the north will terminate at Willesden, and certain others at Wembley, enabling passengers to transfer readily to electric services to complete their journeys. The extent of these amendments to service is an indication of the magnitude of the works to be carried out at Euston within the very short space of five weeks, and we shall hope to publish in a future article some details of the engineering work actually carried out.

Conclusion

Apparatus for the new signalbox, including the 227-lever locking frame, the compressed air system and point mechanism, has been supplied and installed by the Westinghouse Brake and Signal Company, Ltd. This firm has also wired all the apparatus at the outside locations. Train describers were supplied by the Siemens and General Electric Railway Signal Company, Ltd. The cabling and provision of signals and signal structures have been carried out by the regional signal and telecommunications staff under the resident engineer, new works. The whole work is being executed to the specifications and requirements of Mr. S. Williams, Signal and Telecommunications Engineer, London Midland Region, to meet the needs of the operating department. When this work is completed, continuous colour light signalling will extend from Wembley Central into Euston, a distance of 8 route miles.

Australian Refinery.—Work on the Anglo-Iranian Oil Company's refinery at Kwinana, near Fremantle, Western Australia, commenced on October 1st and simultaneously the Western Australian authorities have put in hand a housing programme and the dredging of Cockburn Sound.

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BRITAIN'S ATOMIC WEAPON

WITH the bursting of an atomic weapon amongst the Monte Bello Islands at the end of last week, Britain became the third power in the world to prove its capacity, in conjunction with the Commonwealth, to produce atomic explosions. As yet that is the only firm conclusion that can be drawn from the event. For although the columns of the lay press have been filled with the accounts of eye-witnesses watching from a distance and of the speculations of scientific and military correspondents, no other reliable information has been published. There is the fact, alone, that an atomic weapon, presumably made in Britain, was successfully exploded. The only technical conclusion that can safely be drawn is that arrangements were made to measure and record the effects of the explosion and to derive from those records information of interest to scientists and engineers and of importance to Service and civil defence personnel.

But though many weeks and months must pass before the results of the experiment can be fully assessed and though it is unlikely that very much more information will be made public, its successful outcome must have more immediate repercussions, beneficial not only to the further development of atomic theory but to British prestige as well. The bursting of the weapon made it apparent at a single stroke, how short-sighted an action was the passing by the U.S. Congress of the Atomic Energy (or McMahon) Act of 1946, an Act that forbade the passing on, even to America's allies in N.A.T.O., of information about atomic weapons and fissile material, and thus brought to an end the fruitful pre-existing co-operation between American, British and Commonwealth atomic scientists. The fact that Britain, in addition to Russia, has now proved itself capable of making the weapon demonstrates that merely withholding information about manufacturing methods cannot prevent other nations from discovering them. The scientists of all nations are fully aware of the fundamental reactions involved; and since that is the situation they cannot be prevented from developing, in conjunction with engineers, their own, possibly better, methods of making the weapon. For once the fundamental factors have been discovered, the main deterrent to the making of any technological advance is not in reality lack of industrial "know-how." It is lack of confidence amongst those who must finance the development that the advance can in fact be made or is worth making. But once the technological feasibility has been demonstrated and the value of the product has been proved, secrecy cannot prevent a competitor—a prospective enemy, or a vigorous ally—from making a parallel advance. The McMahon Act, instead of preventing other nations obtaining knowledge about the making of atomic weapons has rather served to cut off American scientists from knowledge of what British scientists have been doing, and it has resulted in the ridiculous consequence that allied British and American scientists and engineers, working upon parallel lines and upon closely related problems, have been unable fruitfully and freely to interchange information. Had that interchange not been interrupted by the passing of the Act, it is probable that it would have furthered a more rapid advance than has in fact taken place in the techniques of manufacturing weapons and utilising nuclear power for more beneficent purposes. Nor is that all. Because there has been no exchange of information, because American and British weapons have been exploded upon different proving grounds, access to which each nation has denied to nationals of the other, there can be no certainty that both will draw the same conclusions about the strategic and tactical methods of using atomic weapons and about the best methods of defence against them. Were the United States and Britain, as allies under the Atlantic Pact, involved in war, such divergencies of view might well prove a dangerous hindrance to combined operations by their armed forces.

But though the explosion of a British atomic weapon should make it obviously desirable, even to the more isolationist members of the U.S. Congress, that the provisions of the McMahon Act should be repealed, it is still welcome news that this country and the Commonwealth have now produced and exploded such a weapon and have, presumably, the capacity to make more of them. For no nation that is without the weapon can any longer be reckoned a first-class world power and had Britain not produced it we should have remained in the future uneasily dependent in diplomacy upon U.S. approval and in war upon U.S. support. We hope, even though the McMahon Act may now be repealed and co-operation be re-established between British and American atomic scientists and engineers, that manufacture of the atomic weapons will be continued if not in Britain at least somewhere in the Commonwealth.

PREVENTIVE MAINTENANCE

In a recent issue of the *Petroleum Refiner* there appeared an article entitled "Preventive Maintenance for Engines and Compressors," contributed by Robert S. Ridgway of the Standard Oil Company of California. The topic is certainly one of ever increasing importance, notably at a time like the present, when the cost of machinery, the cost of fuel and the cost of labour have all reached unprecedented levels. This subject of maintenance has frequently been referred to in THE ENGINEER and we do not hesitate to return to it again after reading Mr. Ridgway's excellent treatise on the subject, a treatise beginning with the following words : "Ever since the days of the old steam engine there have been those who believed that machinery should operate only while it was in good operating condition, and that it should be dismantled and reconditioned before any of the parts became excessively worn. These people were firm in their belief that this practice resulted in better overall economies than operating the machine until it failed to perform properly ; so they established a period of time which they considered a safe run before overhaul. And thus was born the practice of preventive maintenance."

It is important to remember that the increasing complexity of machinery belonging to the categories (internal combustion engines and air compressors) dealt with by Mr. Ridgway, has much intensified the problems both of the designer, the manufacturer and the user. Singular evidence of this was quoted, not very long ago, by the late Dr. Dickinson, who related how the cylinder cover of a Cornish pumping engine at South Crofty had only been lifted once or twice during a period of forty-eight years. A Cornish pumping engine operates, however, under conditions in no respect comparable with the conditions which attach to the modern gas and oil-engine-driven air compressors referred to by Mr. Ridgway. The mean piston speed of the Cornish pumping engine would be about 100ft per minute, or, say, one-tenth of the piston speed of an I.C. engine used for air compressor drive. The comparison in relation to speed is matched by the comparison in relation to complexity, since the quick-revolution I.C. engine embodies a great number of parts, reciprocating and rotating. All these parts are subject to wear, the rate of which will be dependent, other things being equal, upon the quality of the supervision and main-

tenance. With the Cornish pumping engine there were virtually no bearings and no hazard arising from dirt reaching the cylinder. Moreover, the maximum cylinder pressures were extremely low. With the modern I.C. engine the problems arising from the maintenance of piston rings, cylinder liners, valves, bearings, injection devices, springs and the like are such as to require special consideration in respect of spare plant and spare parts. This comes, to-day, at a time when the cost of labour is high and when really skilled labour is hard to come by.

In such circumstances it is more than ever incumbent upon the designer to do all that is possible to develop machines which will make minimum demands on the operating personnel and particularly on the maintenance men. He must remember, further, that the problem of maintenance begins when the equipment is put to work, and if he is sensible he will seek, at every step, the advice of the men who service the machinery. Recently locomotive engineers, when developing a new design, made a full-size model of the cab with all fire-door details, regulator, reversing lever, brake control, pressure gauges, lubricators, windows, weather protection and other equipment in position. The criticism and suggestions of some of the most experienced among the men who would be called upon to drive the projected new engine were then invited. It would be a very good thing if this wise example were followed in the design of other types of plant, so that the skilled fitter could criticise—among other things—the provision made for dismantling and removing connecting-rods, main bearings, &c. Draughtsmen do not have to carry out this sort of work, nor do they hear the blistering comments of the men who must get at inaccessible bearings through inadequate casing doors, or tighten nuts on which it is difficult or impossible to fit the jaws of a spanner. The draughtsman should realise that this work must often be done in ambient temperatures of over 100 deg. Fah. There is something of a passion to-day for what are called "clean lines,"—a phrase relating, presumably, to the outer aspect of the engine. Here we would say that accessibility must never be sacrificed to æsthetics and that no experienced designer would ever make such a mistake. Even if the design is so developed as to facilitate what has been called "preventive maintenance," we still need to provide the requisite parts and in this connection the user has himself to blame if he fails to make the necessary provision. Mr. Ridgway, while stressing the connection between preventive maintenance and economical operation, is well aware that certain operators, instead of working to fixed maintenance schedules, prefer to be guided by "operating data, tests and exterior observations." Much depends, of course, on the nature of the service, the situation of the plant, the position relatively to spare units and the influence of stoppages upon production and profits. Every installation (or type of installation) has its own particular problems and no one will disagree with Mr. Ridgway in his observation that "the maintenance man must be on his toes continually" if he operates without fixed maintenance schedules. On this procedure—which might be described as intermittent rather than systematic—Mr. Ridgway acutely remarks that "although it is a great credit to those who are able to make a practice work out satisfactorily, it is treading on dangerous ground." It should hardly be necessary to remind engine users of the need to be quite certain that the spare parts which they have put into stores are indeed valid for use in the positions for which they are intended. On this point we commend, in conclusion, the following wise advice given by a marine engineer during the discussion of a recent paper on oil engines: "We found that it was a good idea to fit most of our spare parts into the engine at the first convenient opportunity. Some of these parts needed a certain amount of alteration and fitting, but since this was done we knew that the parts we had taken out could be fitted very quickly in an emergency."

King George VI National Memorial Fund

In a broadcast last Saturday night, Mr. Churchill said: "I am sure it is everybody's wish that while our memories of King George VI are still clear and recent, we should take steps to enshrine them in a national memorial." Everyone in this country admired those qualities of King George VI to which Mr. Churchill referred, "of courage, of devotion to duty, of human sympathy and understanding which made him not only honoured but beloved." More directly he gave encouragement to engineers during his life-time by becoming the patron of their major engineering institutions. The proposal is that a statue shall be raised in order to perpetuate his memory; and that the remainder of the money subscribed by his people—by far the major part—shall be devoted to causes that our late King had so closely at heart, that is to the support of the activities of youth and to the care of the aged. It is intended to set up a permanent foundation to be called after King George VI for the spiritual, mental and physical needs both of the young and the old. Very many engineers, we are sure, will wish to contribute, and a suitable form will be found on page 67 of this issue.

Institution of Naval Architects in Italy

During the last two weeks members of the Institution of Naval Architects, which has been holding its Autumn meeting in Italy, have been entertained, together with their ladies, at a number of functions in Genoa, Rome and Naples by their Italian hosts. In our issue of last week we mentioned the visit to the Istituti di Architettura e di Costruzione Navale, which preceded the formal opening of the meeting. After the reading of the papers on Friday morning, September 26th, there was a reception given by the Port Authority of Genoa and in the afternoon the ladies of the party made a tour by coach to Santa Margherita and Portofino. In the evening of the same day all the members attended a dinner given in honour of the occasion jointly by the shipbuilding company, Ansaldo S.A., and the shipping company, Italia S.A.N., at the Hotel Colombia, Piazza Acquaverde. In the morning of the following day the ladies paid a brief visit to the Palazzo Bianco museum, while the delegates were shown round the Sestri shipyard of Ansaldo S.A. before taking train for Rome.

An early departure was made from Rome on Sunday morning, September 28th, to visit the Nemi Naval Museum to see models of the boats recovered from Nemi Lake. The two original vessels, unfortunately destroyed during the war, had a length and breadth of 71·3m by 20m and 73m by 24m, respectively, and were used for religious ceremonies concerned with the cult of Diana. Returning to Rome, the delegates attended a reception held by the Ministry of Defence—Navy Branch, at the Circolo delle Forge Armati, Pallazzo Barberini, before proceeding to the Hotel Excelsior, via Vittorio Veneto, to a luncheon given by the Registro Italiano Navale. Admiral Baroni, the president of the Registro Italiano Navale, welcomed the guests and Mr. Leslie Champness replied on behalf of the Institution of Naval Architects, being supported by Sir Ronald Garrett, the chairman of Lloyd's Register of Shipping, while Professor Della Ragine spoke for the Associazione Italiana di Tecnica Navale. During the afternoon of the same day the famous Villa d'Este at Tivoli was visited. The visit to Rome concluded with a reception in the Campidoglio at the invitation of the Mayor of Rome, who received the members of both technical societies.

The delegates travelled on to Naples on Tuesday, September 30th, and on the same evening visited the Mostra d'Oltremare e del Lavora Italiano nel Mondo, where they were welcomed by the Presidente of the Mostra, Professor Ing. Louis Tocchetti. After a tour of the exhibition the guests attended a reception by the Tirrenia, S.p.A. di Navigazione. On the following morning the delegates travelled in motor-coaches, placed at their disposal by the Cantiere Navale Pellegrino, to Pompei, where they visited the Villa dei Misteri, the excavations and the museum. Afterwards the party continued along the coast road to Sorrento, where they were entertained to luncheon by the Presidente della Navalmeccanica, Comm. J. A. Pattison, at the Europa Palace Hotel. On the return journey to Naples a short visit was paid to the Cantiere della Navalmeccanica di Castellammare di Stabia to see something of the shipyard. On the last day the members and their ladies took part in an excursion to Capri, making the short sea voyage in the motor vessel "Abbazia," and returning in the same ship after having a short tour of the island and visiting the Blue Grotte. The Autumn meeting in Italy closed with a reception in the Palazzo San Giacomo by the mayor of Naples, Com. Achille Lauro, when both welcoming and farewell speeches were made.

BOOKS RECEIVED

The Nile. By H. E. Hurst. London: Constable and Co., Ltd., 10, Orange Street, W.C.2. Price 30s.

Die Gasturbine. By J. Kruschik. Germany: Springer-Verlag in Wien, 1, Molkerbastei 5, Price 107s.

Street Lighting. By J. M. Waldram. London: Edward Arnold and Co., 41, Maddox Street, W.1. Price 65s.

The Engineers' Illustrated Thesaurus. By Herbert Herkimer. Cambridge: W. Heffer and Sons, Ltd. Price 42s.

Engines for Power and Speed. By F. E. Dean. London: Temple Press, Ltd., Bowling Green Lane, E.C.1. Price 9s. 6d.

Studies in Elastic Structures. By A. J. S. Pippard. London: Edward Arnold and Co., 41, Maddox Street, W.1. Price 60s.

The Technograph System of Printed Circuits. London: Technograph Printed Circuits, Ltd., 32, Shaftesbury Avenue, W.1.

Metallurgical Abstracts. Edited by N. B. Vaughan. London: The Institute of Metals, 4, Grosvenor Gardens, S.W.1. Price 60s.

Industrial Leadership and Joint Consultation. By W. H. Scott. Liverpool: The University Press of Liverpool, 3. Price 12s. 6d.

Climatological Atlas of the British Isles. London: Her Majesty's Stationery Office, York House, Kingsway, W.C.2. Price £2 12s. 6d.

Concrete Roads. By F. N. Sparkes and A. F. Smith. London: Edward Arnold and Co., 41, Maddox Street, W.1. Price 80s.

Surveying and Field Work. By J. Williamson. Third Edition. London: Constable and Co., Ltd. 10, Orange Street, W.C.2. Price 40s.

Obituary

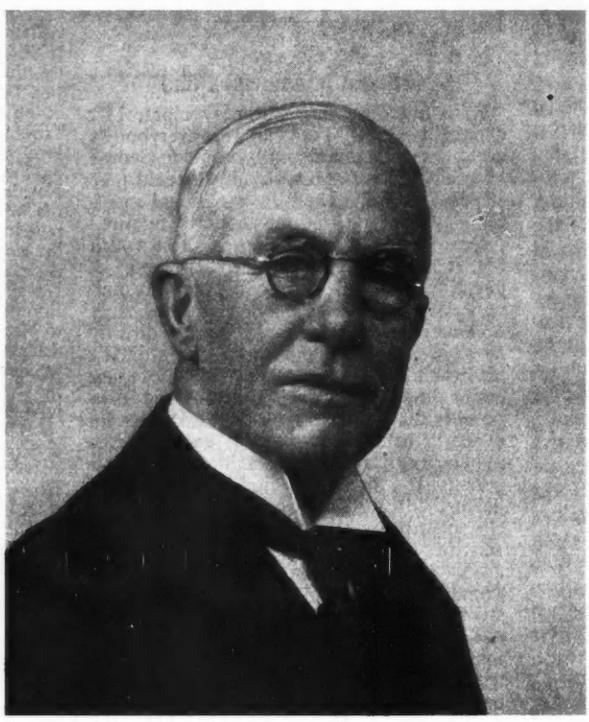
PROFESSOR F. C. LEA, O.B.E.

We record with deep regret the death of Emeritus Professor Frederick Charles Lea, which occurred on Tuesday, September 30th, at his home, Wayside, Dore, Sheffield. Professor Lea, who was eighty-one, made, during his long and distinguished career, a noteworthy contribution to the cause of technical education in this country. His teaching work was begun, at the close of last century, at the City and Guilds (Engineering) College, and was subsequently continued for nearly forty years at the Universities of Birmingham and Sheffield.

Frederick Charles Lea was born at Crewe on June 25, 1871, and received the earlier part of his education at the Crewe Mechanics' Institution. Subsequently he became a student at Owens College, Manchester, and, later, at the Royal College of Science in London. Professor Lea's practical training as an engineer was obtained by an apprenticeship at the Crewe works of the London and North Western Railway Company, under the late F. W. Webb. After its completion he spent a few years in railway service. One appointment during those years was as an assistant engineer at Holyhead harbour, where he was engaged mainly on dynamo and lighting installations. It was followed by a three-year period, from 1896 to 1899, as an assistant in the constructional office at Crewe of the chief engineer of the London and North Western Railway. In 1896 also Lea was appointed a Whitworth Exhibitioner.

Professor Lea's teaching career began at the City and Guilds (Engineering) College in 1899. In that year he became chief assistant to Professor W. Cawthorn Unwin and Professor W. E. Dalby, a position in which he remained for the next twelve years. Professor Lea was then appointed to the engineering inspectorate of the Board of Education, in which service he spent two years. Early in 1913, Professor Lea was invited to the Chair of Civil Engineering in the University of Birmingham. His years of service there were particularly arduous ones on account of the demands of the first world war, which broke out within a year or so of taking up his work at Birmingham. Professor Lea was quickly called upon to serve on various technical committees set up by the Government to assist the war effort. His principal work during the succeeding four years was related to researches into materials best suited to the construction of aircraft and aero-engines. It was work that was ably undertaken in the laboratories of Birmingham University and in those of various factories in the district. Years afterwards, Professor Lea recalled the investigations which led to the development of all-metal aircraft, the results of much of his work being recorded in reports published by H.M. Stationery Office and in the *Proceedings* of learned societies. In recognition of his work during the first world war, Professor Lea received the O.B.E. Professor Lea continued his work as Professor of Civil Engineering at Birmingham University until 1924, being responsible during his years there for many additions to the equipment of the engineering laboratories and for the design of much apparatus required for special researches with which he was concerned. In 1924 Professor Lea was appointed Professor of Engineering and Dean of the Faculty at the University of Sheffield, retiring from those offices in 1936, when he was given the title of Emeritus Professor. For some years following his retirement from the University he served as a director of Edgar Allen and Co., Ltd., and also engaged in some consulting work.

During his lifetime Professor Lea made numerous contributions to the technical literature of those subjects on which he was a recognised expert. His books on *Hydraulics* —the first of which appeared in 1908—ran into several editions, and there also came from his pen many papers, dealing with the properties of metals and structures, which appeared in the *Proceedings* of learned societies and in the technical press. To the work of the professional institutions of which he was a member, Professor Lea rendered valuable assistance. He was elected to associate membership of the Institution of Civil Engineers in 1901, becoming a full member in 1918. He was a Crampton and a Telford prizewinner of the Institution. Professor Lea was elected a member of the Institution of Mechanical Engineers in 1921, and was chairman of its Yorkshire branch in 1926. He was chairman of the Institution's education committee for several years, and chairman of its welding research committee from the time that committee was set up in 1931 until it was dissolved in 1939. In the latter year Professor Lea was elected a vice-president of the "Mechanicals" and in 1943 he succeeded to the presidential chair. It is appropriate to recall now that, on the occasion of his presidential election, Professor Lea said characteristically that he accepted the honour which had been conferred upon him as a compliment to those professors and teachers in the technical colleges of this country who had done so much to assist in the great work of the education of young engineers.



Professor F. C. Lea

Undoubtedly, Professor Lea was among the foremost of those who during the century have enhanced the standard of technical education. It was fitting that in his presidential address to the "Mechanicals"—to which he gave the title "Remember the Past and Look to the Future"—he surveyed progress in the science and practice of engineering and in engineering education. He claimed that although inventive ability, workshop technique and practical success were necessary to success in mechanical engineering, development could not depend on them alone. Theory and sound practice, Professor Lea urged, were not two distinct aspects of engineering, but, rightly understood, were complementary. Professor Lea held that the designer must not only be familiar with the well-established principles of engineering theory which formed the groundwork of the engineering schools, but must also fully appreciate their limitations, and the point at which he must turn for guidance to experimental knowledge which had not yet been embodied in strictly co-ordinated theory. Another view which Professor Lea always emphasised was that students, during their university courses, should visit mines, iron and steel works, fabrication departments, and machine shops, and should see the final assembly of particular articles in the specialised works. They would thus get a picture of the whole process of converting raw materials into the finished article, and would have at least some appreciation of the economic and human problems involved. These views, expressed in his presidential address, indicate how the education of young engineers was a constantly recurring theme in his thoughts. He took an active part in the discussions of a subject about which so many different opinions have always been held and continue to be held to this day.

Much of Professor Lea's success in life was undoubtedly the consequence of the careful attention he was always ready to give to detail and his insistence that before any decision was reached every factor that could possibly weigh upon it should be brought to light. On occasion, it is true, he was not blessed by his fellows when he insisted upon detailed discussion at the many councils and committees upon which he served. Yet they had to admit that he could thereby sometimes bring about fruitful modifications of view or, at the very least, make the members of a committee more surely aware that a decision reached was really soundly based so that there could be no thought of questioning it in the future. Though this trait might sometimes create a temporary irritation, it never could affect the respect and affection felt for him by those with whom he worked. For he was kindly, considerate and wise in his dealings with his fellows; and to younger folk he proved always not only courteous and kind—few of the eminent are not—but also

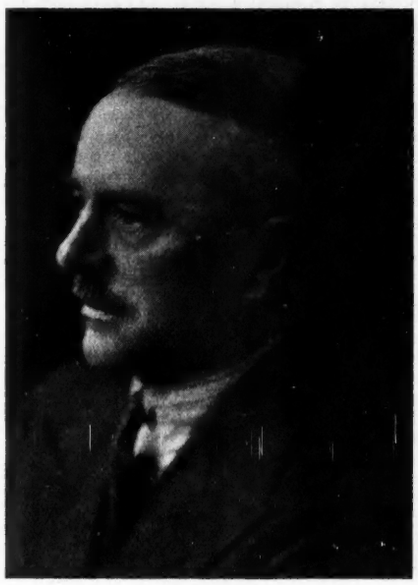
at all times really active in help.

In addition to his membership of and work for the two major institutions of which he was a member, Professor Lea was a member of the Institution of Structural Engineers, an honorary Fellow of the Imperial College of Science and Technology, and a past-chairman of the Whitworth Society. He also served, in 1929, as president of Section G (Engineering) of the British Association for the Advancement of Science. His degrees included D.Sc. (London) and M.Sc. (Birmingham).

SIR ARCHIBALD McKINSTRY

It is with regret that we record the death of Sir Archibald McKinstry, which occurred on Monday, October 6th, in London. Sir Archibald, who was in his seventy-fifth year was, until earlier this year the vice-chairman of the Metal Box Company, from which position he had resigned at his own request.

Sir Archibald was born in County Antrim, Ireland, in 1877, and received his early education at the Grammar School, Larne, after which he took an Honours course in mathematical and experimental physics at the Royal University of Ireland, and graduated Bachelor of Arts in 1898. He continued



Sir Archibald McKinstry

his studies at Queen's College, Belfast, on a post-graduate course and then served an apprenticeship with the British Westinghouse Electric and Manufacturing Company, Ltd., from 1902 to 1907. During these years, he was trained as an electrical and mechanical engineer, acting as an assistant engineer on several of the company's contracts and eventually being appointed engineer-in-charge.

In 1911, Sir Archibald went to Australia as representative of his company to supervise various contracts and electrical schemes then under way in Australia and New Zealand. He remained abroad for several years and became Director of Munitions, Commonwealth Government of Australia, during the latter part of the first world war, and Electricity Commissioner for the State of Victoria, Australia, in 1918. In 1919 he was given his degree of Master of Science by the University of Melbourne. He visited the United States of America and Canada in 1920–21 on matters of electrical interest, and continued to be associated with the Metropolitan-Vickers Electrical Company, Ltd., of which he was a director, and the Metropolitan-Vickers Electrical Export Company, Ltd., of which he was chairman until 1930, when he severed his connection with these interests. In addition to his business activities, he served as a director of the British Broadcasting Corporation from 1922 to 1927, and in 1929 visited Spain as a member of the trade mission of the Federated British Industries.

After leaving the electrical industry, Sir Archibald joined the board of Babcock and Wilcox, Ltd., and a year later, in 1932, he was appointed managing director, which position he continued to hold until 1944, when he retired. He continued, however, to be a director and it was not until 1951 that he resigned from the board owing to advancing years. During this period he was also connected with the Metal Box Company, Ltd., of which he was made a director in 1941, subsequently becoming vice-chairman of the company. Sir Archibald held that office until July of this year, when he resigned, but continued to be a director.

Sir Archibald served on many government committees, both during and after the second world war. He was a member of the Industrial Panel of the Ministry of Production in 1942, and in the following year was a representative of the Ministry of Supply on the Munitions Management and Labour Efficiency Committee of the Ministry of Production. In 1947 he acted as a member of the Appeal Tribunal and served on the Royal Commission on Awards to Inventors. Sir Archibald, who was knighted in 1943, was a member of the Institution of Electrical Engineers and of the Institution of Mechanical Engineers, and also of the Royal Institution of Great Britain.

HARRY CUNNINGHAM

We have learned with regret of the death of Mr. Harry Cunningham, M.I.C.E., which occurred last Sunday, October 5th, at Bearsden, Dumbartonshire. Mr. Cunningham, who was seventy-five, was particularly well known among civil engineers as chairman and managing director of Sir William Arrol and Co., Ltd., Glasgow, with which firm he had been associated for almost the whole of his career.

Harry Cunningham was educated at Speirs School, Beith, and subsequently served a pupilage with Messrs. Crouch and Hogg, consulting civil engineers, Glasgow. Upon its completion he joined the chief engineer's staff of the Caledonian Railway Company, and, while still in his twenties, became resident engineer on the construction of the railway bridge over the River Clyde at Glasgow Central Station. There his work attracted the attention of the late Sir William Arrol, and Mr. Cunningham was appointed to his staff to take control of bridge contracts at Barrow-in-Furness and in London. Thus, there was begun the association with Sir William Arrol and Co., Ltd., which continued until Mr. Cunningham's death. He was elected a director of the company in 1913, and took a great deal of the responsibility of the management of the business in the strenuous years of the first world war. In the years between the wars Mr. Cunningham travelled extensively abroad in the interests of contracts secured by his firm in many parts of the world. He was appointed chairman of the company in 1935 on the retirement of Sir John Hunter. During the second world war, in addition to his arduous duties for Sir William Arrol and Co., Ltd., Mr. Cunningham gave valuable service as chairman of the British Constructional Steelwork Association. In that office he was called upon to co-ordinate the resources of the structural steelwork industry on programmes of special production such as landing craft, prefabricated sections of frigates and corvettes, and components for the "Mulberry" harbours.

There were many other organisations which benefited greatly from Mr. Cunningham's experience and wise counsel. He had served as chairman of the Association of Cranemakers, chairman of the national technical committee of the Engineering and Allied Employers National Federation, and chairman of the Scottish section of the Federation of Civil Engineering Contractors. He was also a director of the North-West Rivet, Bolt and Nut Factory, Ltd., the Rivet, Bolt and Nut Company, Ltd., and the Power and Traction Finance Company, Ltd., and had formerly served on the boards of the Lanarkshire Steel Company, Ltd., and the Galloway Water Power Company, Ltd. Mr. Cunningham was elected an Associate Member of the Institution of Civil Engineers in 1903 and a full Member in 1920.

Railway Facilities for Newport Power Station

In order to transport the large quantities of coal required for the new power station at Uskmouth, Newport (Mon), a considerable scheme of alterations has been carried out by the Western Region of British Railways. The engineering work which has been carried out included the conversion into a double line of the 3 miles of single track on the East Usk branch, which leaves the South Wales main line near Somerton Road Bridge, Newport. Apart from the length of new permanent way required, the scheme involved the widening of several bridges to accommodate the second line of rails.

Two new signalboxes have been erected, one near the Corporation Road Bridge and the other at Uskmouth at the end of the branch, which connects with the large siding layout of the British Electricity Authority. Owing to the distance from the signalboxes certain of the points are electrically operated. Loop lines have been laid at Corporation Road signalbox to enable traffic for the works situated on the branch to be dealt with whilst trains of coal and empties to and from the power station are passing.

The siding accommodation at East Usk Junction marshalling yard is also being increased and new staff buildings provided.

It is expected that the delivery of coal will start immediately, and when the new power station is finally completed it is anticipated that twelve to fourteen trains of coal will pass daily together with a corresponding number of empty wagon trains in the reverse direction.

The new facilities will also be of considerable use in dealing with traffic to and from the works adjoining the branch and any new factories which may be built in the future.

Human Relations in Industry.—The Ministry of Labour has now issued a comprehensive report of the conference on "Human Relations in Industry," which was held in London from March 18th to 20th last. The conference was called by the Ministry for the purpose of assessing the results of action taken concerning human relations in industry during the past few years by the various bodies interested, and of considering what still needed to be done. It was attended by about 400 delegates and observers from the British Employers' Confederation, the Trades Union Congress, the managements of nationalised industries, several Government departments, and a great many institutions and voluntary organisations dealing with the problems of labour in industry. The report includes the opening address of Sir Walter Monckton, Q.C., Minister of Labour and National Service, and statements by Sir Cuthbert Clegg, president of the British Employers' Confederation, and Mr. T. Williamson, of the general council of the Trades Union Congress, on "Some Conclusions About Human Relations in Industry Drawn from the Reports of the Anglo-American Productivity Teams." There is also a statement by Sir George Schuster, chairman of the Panel on Human Factors in Industry set up by the Committee on Industrial Productivity, on "Some of the Projects Sponsored by the Schuster Panel." The report, which sets out in full the discussions and conclusions of the conference, may be obtained from H.M. Stationery Office, price 3s. 6d.

Education in Electrical Engineering

Last night, Col. B. H. Leeson, the new President of the Institution of Electrical Engineers, presented his Inaugural Address. It was entitled "Electricity and Current Affairs," and it surveyed the contribution of electrical engineers and the electrical manufacturing industry to the economy of this country. We have chosen here to print an abstract that is concerned solely with the education of electrical engineers.

THE Institution's educational policy is the seed and sustenance of progress. Stated summarily, it is that a man's education and training should be based on the broadest concepts of general and scientific learning, and above all should aim at giving him a general appreciation of life and at developing his character. In this way he will be fitted to pursue the occupation he finds most suitable between the extremes of specialisation and generalisation.

The pre-eminence of British contributions to electrical engineering is proof of the effectiveness of this policy and the need for its continuance in improved educational facilities now imperative for all grades of personnel, not only those within the generic group of the technologist, but also in those of the technician and the craftsman, whose needs are equally pressing. These groups, like colours in the spectrum, merge into one another and are difficult to define except in general terms.

The personnel in the three generic groups can advance from one to the other, and the Institution has done much to achieve this, whilst some by the nature of their work and recognised qualifications may be in a marginal overlap between two groups.

The professional engineer may be grouped with the applied scientist as a technologist, and in the provision of further education for the group the universities have a more unified task than the large technical colleges, which are concerned as well with the technician and craftsman with their greater diversity and specialisation.

With regard to Corporate Membership of the Institution, the important point is that the universities with full-time education and the technical colleges with courses, whether of a part-time, sandwich, or full-time character, each based on industry and the profession, both provide for the potential professional engineer. Between these different, but complementary, approaches to corporate membership, any man with ability has the opportunity to work his way up and become a Chartered Electrical Engineer.

It is interesting to compare the relative characteristics of these two approaches. The university approach is based on a full-time course and on practical training in industry, usually acquired subsequently. The undergraduate benefits from acquiring the fundamentals of engineering science, coupled with wider knowledge accruing from university life, that later can be turned to any particular use. Unless, however, he has previously had a probationary period in industry (and a period of one year is most helpful) the undergraduate has little opportunity of appreciating practical engineering, and on entering industry has to adapt himself to a different mode of life.

The technical college approach is based on apprenticeship in industry, combined with part-time or whole-time study. The student apprentice has the benefit of experience in practical engineering and the ways of industrial life. His education needs to equip him with the scientific and fundamental principles of engineering and their general application outside his everyday purview.

The different environments of these two approaches, if matched to the differing characteristics of the men themselves, are of practical value in suitably filling the diverse variety of industrial and other tasks. As the men get older, the particular characteristics of their earlier training tend to lose their sharpness of outline, and neither approach can be said to be inherently preferable, because, in the long run, the character and ability of the man himself invariably prove the predominating factor.

I have dwelt somewhat fully on these fundamental aspects because they form the bases on which further educational progress should be created and also provide criteria for judging new projects and their enhancement of hard-earned standards of world-wide reputation.

Technologists

For many years there has been a general recognition of the need for a greater number of technologists in order to bring scientific discoveries more quickly into application, to meet the growth of industry and in other ways to foster progress and productivity.

The Council considers that there is an imperative need for a greater number of technologists to be forthcoming each year, both from the universities and the larger technical colleges, and that delay in meeting this need is fettering progress. The universities have doubled their pre-war output of technologists, but an increased rate is still needed, and the number who graduate in applied science as compared with pure science does not meet the requirements of present-day life. The larger technical colleges need to be granted means to increase their contribution in the field of technology, both at the graduate and post-graduate levels.

This need for more technological education has been much emphasised in recent years in the Percy and other reports. A vast amount of consideration has been given in highly competent quarters to the problem, but unfortunately progress falls short of requirements. The problem is urgent ; and in an attempt to bring matters to a head I think it would be helpful if I outlined some concepts that take into account the progress so far made, and that would extend British characteristics of education and training.

The contributions required from the technical colleges in higher technological education would be met most economically and speedily by being concentrated on a regional basis in a few of the larger colleges designated for that purpose. More colleges would be so designated as the necessary facilities permitted.

Each college, as distinct from a department of a college, would require first-class accommodation, equipment and facilities, and would be run by a highly-qualified staff. Its departments of applied science would be supported by other equally efficient departments of, for example, mathematics and physical science, and stimulated by research activities.

The college would have academic freedom under a self-governing representative administration (including industrial representation) and would not come under the direct control of the local education authority. With an adequate standard of entry the college would function with internal autonomy as a unit in close touch with neighbouring colleges and industry.

The courses in the various technologies, which might be chiefly sandwich courses, would be industry-based and broadly conceived on a wide basis of fundamental science and on the experience of their respective learned professions or societies. There would also be facilities for work of a post-graduate standard, carrying forward the frontiers of the various techniques. The prestige of the college and of its awards would have to be earned—not assigned.

The first essential to this objective is the setting up of a small body (including a few men of high academic and professional status) under the ægis of the Government with the necessary finance and authority to select and guide the chosen colleges in consultation with professional bodies, learned societies and industry.

It would be the duty of every section of the industry to provide facilities for additional and improved training matched to the higher standard of education—a duty rich in its own economic reward.

The concepts envisaged would extend, instead of conflicting with, the characteristics of education and training so dear to the British heart. In contrast, technological education in some countries is essentially college-based ; and though there is a trend towards a larger content of the humanities and though it is associated with development-research, it does appear to present an end in itself. Whilst this form of education may be suited to the national character and traditions of those countries, it does not follow that an "Englische Technische Hochschule" would suit conditions here.

In this country there is a much wider field to cover. Britain has always been a country of inventiveness, research, fundamental development, colonisation, overseas trade and world-wide interests, and our educational policy has grown up in line with these broader and greater needs. For these very reasons, British education is prized overseas.

Technicians

The Council is obviously no less interested and active in promoting increased and better education and training for technicians, who outnumber technologists by at least five to one, and are themselves outnumbered by the craftsmen of the industry. As the functions of the Institution are limited by its Charter to the needs of the professional engineer, this means that other bodies or associations should cater directly for the needs of the technician. It is highly preferable for a technician to have full status in his own association than an indefinite status on the fringe of a body constituted for a different purpose. Similarly, his education and training must form the subject of separate study, and the Institution has co-operated with the Radio Industry Council and the British Electrical and Allied Manufacturers' Association in making recommendations.

As technicians are so widely dispersed and the range of their work is so varied and specialised, the task of catering adequately for their needs presents some difficulty. A special committee of the Institution is studying this important question. There are two needs to be met : the first, and foremost numerically, is to improve the facilities for a technician to become a first-class technician, and the second is to ensure that for men of the right aptitude, the facilities serve as a stepping-stone in the formation of a professional engineer.

Annual Report of the British Electricity Authority

The fourth annual report of the British Electricity Authority was published last Tuesday. A summary of those sections of the report likely to interest engineers is printed, together with fuller extracts from certain sections of the report.

Production and Trading

THE main production and trading features of the year ended March 31, 1952—the fourth year of operation of the British Electricity Authority and the fourteen Area Electricity Boards—were as follows :—

Over 59,250 million units of electricity were generated at the power stations owned by the Authority. At the end of the year there were over 13½ million consumers and sales of electricity to consumers exceeded 50,400 million units. Roughly half the sales were to industry, a third to domestic consumers, and an eighth to commercial consumers. Industrial consumption was 9·9 per cent more than in the previous year, domestic 7·1 per cent more and commercial 6·5 per cent more. The average price received for electricity was 1·220d. per unit. The combined revenues of the Authority and the Area Boards exceeded by £2,918,837 the amount of their combined expenditures properly chargeable to revenue account. This surplus, together with the surpluses for 1948–9, 1949–50 and 1950–1, give a total of £20,800,934 for the four years since vesting day. The combined revenues of the year totalled £263·91 million, of which £256·39 million, or 97·15 per cent, came from sales of electricity to consumers. The combined expenditures on revenue account totalled £260·99 million, the largest items being £125·22 million (47·45 per cent of combined revenues) on generation works costs and small purchases of electricity from outside sources, and £62·96 million (23·86 per cent of combined revenues) on capital charges, almost wholly depreciation and interest. The combined capital expenditures incurred by the Authority and the Area Boards during the year totalled £141·68 million, of which £89·66 million related to the Authority and £52·02 million to the Area Boards. About 90 per cent of the capital expenditure incurred by the Authority was on power station construction and extension.

Generation and Main Transmission

Generating Capacity and Programmes.—At March 31, 1952, the Authority owned 293 power stations, with a total installed generating plant capacity of 15,768,779kW and a total output capacity with all plant in service of 14,214,000kW. Compared with a year earlier, the net increase in output capacity was 1,058,000kW, or 7·4 per cent. Because of the shortage of generating plant, it is still necessary to retain in operation many generating sets and boilers which are old, small and expensive to operate. More than two-fifths of the steam-driven generating sets, representing 14·6 per cent of the total installed capacity of such sets, and almost two-fifths of the boilers, representing 12·8 per cent of the total evaporative capacity, were twenty-five years old or more. Nearly half the sets, representing 8·8 per cent of the total installed capacity, had individual capacities of less than 8000kW, as compared with present-day standards of 30,000, 60,000 and upwards. A third of the boilers, representing 7·1 per cent of the total evaporative capacity, had individual capacities of less than 40,000 lb per hour, as compared with the 250,000–550,000 lb range for most of the boilers under construction.

The new generating set and boiler capacity brought into service was distributed among twenty-eight power stations and gave an additional output capacity of 1,192,000kW (sent out), which was much more than that installed in any previous year. The stations included ten large new ones which were opened during the year. Plant having an output capacity of 119,000kW was shut down to make room for new plant or because the plant had become unserviceable.

At the end of the year, forty-one new power stations and thirty-seven extensions of power stations were under construction or planned in the plant programmes for the period up to and including 1957.

In their first three years of operation, the Authority prepared programmes of new generating plant to come into operation in the calendar years 1953–6 inclusive, and also provisional programmes for 1957 and 1958. During the year under review a final programme was prepared for 1957, the provisional programme for 1958 was revised, and a tentative programme was prepared for 1959, each of the three amounting to some 1,900,000kW of output capacity. Progress may, however, be retarded by external factors, such as re-armament or restrictions on capital investment. Altogether, the plant programmed for the calendar years 1947–57 inclusive amounted to 13,299,000kW (sent out), of which 2,859,000kW had been brought into service by the end of 1951.

The sizes of the very large plant programmes now in hand are governed by the amount of manufacturing and construction capacity likely to be available. It was estimated that as a result of these programmes new plant would be brought into operation at increasing rates, as follows :—

Calendar year	kilowatts (sent out)
1952	1,150,000—1,400,000
1953	1,300,000—1,500,000
1954	1,400,000—1,600,000
1955	1,500,000—1,700,000
1956	1,600,000—1,800,000
1957	1,700,000—1,900,000

For each year, the lower amount is that which may be expected with confidence, and the higher amount that which may be possible, if nothing untoward affects existing plans.

As stated in previous reports, the Authority's programmes are physically capable of achievement, provided they are not affected by other national considerations, such as re-armament or restrictions on capital investment. Current uncertainties make it impossible, however, to give any firm promise as to when generating capacity will be sufficient to meet all demands ; but if the growth in demand accords with expectation and all goes well with the programmes, power cuts should be comparatively infrequent by the winter of 1954–5 and very exceptional in the three following winters, even in extremely cold weather. This conclusion is not invalidated by the relatively favourable experience of the 1951–2 winter, when there was much less load shedding than had been expected. In part, the improvement was due to a further speeding up of plant overhaul during the summer months, in part to a larger amount of load spreading, and in part to the weather conditions, which on the whole were moderate and without long periods of severity ; but an exceptional and, it is believed, temporary factor, was a fall in the rate of increase of basic demand, arising chiefly from a slackening of industrial activity. Even so, there were many occasions during the winter when a slightly higher demand would have resulted in further load shedding.

The provision at all times of adequate supplies of power for industrial and other consumers is dependent on the achievement of the plant programmes, and the Authority, therefore, continues to be seriously concerned about Government proposals, in the apportionment of national capital investment, to limit the annual amounts of new generating plant to 1,550,000kW (sent out). As stated in the 1950–1 report, the onerous and difficult nature of the Government's responsibility for ensuring the best use in the national interest of scarce materials, production capacity and labour is fully recognised. But the proposed limit on the amount of new plant would not only prolong the conditions of severe plant shortage and load shedding. It would also hinder that greater mechanisation and extended use of power in industry which can make the most effective contribution to the nation's improved industrial efficiency and productivity.

Planning and Construction of Power Stations.—In the successful planning of new generating capacity for years ahead, to provide adequate power supplies at the lowest cost, much depends on the accuracy of the forecasts of sources and qualities of fuel for individual power stations. Close co-operation is maintained with the National Coal Board. In 1950–1, the Authority had furnished the Board with a detailed statement of estimated coal consumption at each of its existing and proposed power stations in 1960–1, and during the current year the Board provided a forecast of the pattern of supplies to the Authority. This forecast placed even greater emphasis than hitherto on supplies from the developing East Midlands coalfield, and generation and transmission developments are being planned accordingly. Close contact was also maintained with the Railway Executive on the arrangements for transporting coal. There were also discussions with the National Coal Board on the possibility of utilising for generating purposes the " slurries " and " washery rejects " which are left after coal has been cleaned at the collieries. This very low-grade fuel has a high ash-content, cannot be transported economically over long distances, and hitherto has been practically unmarketable. It was decided that, as a first step, the Authority and the Board should each build a power station specifically designed to burn this fuel and situated as near as possible to the associated coal treatment plant.

As a short-term measure to assist in overcoming the present plant shortage, the Authority decided to install about 100,000kW (installed) of diesel engine generators in smaller obsolete power stations and in other buildings. This type of plant is not economical when compared with modern steam-driven plant, but it can be installed with relative ease.

Having regard to the increasing difficulty of discovering new power station sites which are technically suitable and also acceptable from other points of view, the number of sites found during the year was not unsatisfactory.

Two-thirds of the capacity included in the 1957 plant programme consists of " standard " 30,000kW and 60,000kW generating sets, while a fourth of the capacity is planned to operate at a steam pressure at the turbine stop-valve of 1500 lb per square inch.

The Grid System.—The major transmission works put in hand during the year included 145 route-miles of 132,000V overhead lines and approximately 218 route-miles at 275,000V. The latter works comprise the double-circuit lines of sections of the new 275,000V supergrid from Staythorpe (Newark) via Elstree to Slough, from Staythorpe to Drakelow (Burton-on-Trent), from Drakelow to Carrington (near Manchester), and from Drakelow to Hams Hall (near Birmingham), the last section to operate initially at 132,000V. The total value of contracts placed during the year was £27·7 million, compared with £10·7 million in 1950–1 ; £10·6 million related to the supergrid.

Generation of Electricity.—The overall thermal efficiency of generation continues to rise as new high-efficiency plant is brought into operation, but much is also being achieved by careful attention to the condition of existing plant, improvements in the distribution of fuel, and the optimum loading of plant. The average thermal efficiency of the Authority's steam power stations has risen steadily, from 20·86 per cent in the pre-vesting year 1947–8, to 21·15 per cent in 1948–9, 21·33 per cent in 1949–50, 21·54 per cent in 1950–1 and 22·04 per cent in 1951–2. The shortage of plant in recent years has necessitated the increased loading of plant of relatively low efficiency, and correspondingly retarded the improvement in average thermal efficiency.

Between 1947–8 and 1950–1, there was a continuous increase in the loading of power station plant, the average load having risen from 41·2 per cent to 47·1 per cent of the maximum output capacity. Because, however, of the falling-off in the rate of increase of demand during the second half of the year, the average load for 1951–2 was slightly lower, at 46·9 per cent, than that for 1950–1.

System Operation.—Operating conditions on

the grid system remained difficult throughout the year because of the continuing shortages of generating plant capacity and of interconnection capacity between main sections of the system. The estimated shortage of generating capacity at the time of maximum potential demand, which occurred on December 11, 1951, was 1,192,000kW (sent out), compared with 2,219,000kW in the previous winter. This was equivalent to over one-twelfth of the maximum potential demand, and it was estimated that the shortage would have been 2,550,000kW if the weather had been extremely cold and there had been no load spreading arrangements by industrial and commercial consumers.

The pattern of load shedding showed a decided change. Most shedding took place in the summer months, whereas in 1950–1 it was mainly confined to the winter. Although there were many occasions during the winter months (October-March) of 1951–2 when a small increase in demand would have resulted in further load shedding, the number of occasions of load shedding was only two-fifths of that for the corresponding period of 1950–1 ; the number of disconnections of supply (power cu's) was only six as compared with eighty-six. The substantial improvement in the winter plant/load position was due to the large amount of new generating plant installed during the year ; the acceleration of the Authority's main programme of plant overhaul during the summer months ; a reduction in the loss of plant capacity due to breakdown, unsuitable fuel and other causes, as compared with the previous winter ; the larger amount of load spreading ; the improved weather conditions ; the improved supplies of domestic solid fuel ; and the reduction in the rate of increase of demand for electricity, arising chiefly from a slackening of industrial activity.

Private Generating Plant

Because of the continued shortage of generating plant, some firms, under contract to purchase the whole of their electricity requirements, have had under consideration the installation of private plant either as an insurance against load shedding or to enable them to reduce their load on the public supply system during peak load periods, to the extent requested by the Regional Boards for Industry. Accordingly, since vesting day, discussions have taken place from time to time, between the Authority, the Area Boards and the Federation of British Industries regarding the relaxation of restrictions in existing agreements on the use of private plant. During 1951–2 the matter was further reviewed, and as a result the Authority and Area Boards agreed to relax the restrictions until March 31, 1959, subject to the terms and conditions of supply being adjusted to give the necessary financial and technical protection to the Boards. A model clause for endorsement on supply agreements, which would override for such a period any restrictive conditions contained in the agreements, was accordingly agreed with the Federation.

The Authority do not consider that in general, and as a long-term policy, the installation of private plant is economic and in the national interest. Except in special cases, the installation and operation of such plant will make a greater call on labour and materials than a corresponding service from the public supply system. Plant which forms part of that system, being pooled for general use, is used to greater advantage, and enables considerable economies in coal to be effected by the relegation of older and less efficient plant to peak load operation. Moreover, there are few opportunities for the installation by consumers of ordinary condensing generating plant with an efficiency approaching that of the large units installed by the Authority.

Where, however, process steam is required in factories, fuel economies may be effected by the installation of back-pressure generating plant ; industrial installations of this special character may be economically justified where the process steam requirements are fairly substantial, and where over the life of the plant a reasonable balance of the steam and electricity requirements can be assured. In such cases, to obtain the most economical results, suitable arrangements should be made for the operation of the plant in parallel with the public supply system, and for the interchange of electricity supplies. The appropriate arrangements will depend on individual circumstances, which are likely to differ widely. It is desirable, therefore, that all projects should be examined in consultation with the Electricity Boards concerned, to ensure that the most economical schemes are adopted. The Boards are well aware of the part which back-pressure plants can play in conserving coal, and are fully prepared to co-operate with industrialists willing to install them.

Miscellaneous

The first of two 15,000kW experimental gas turbines was installed, and it was expected that both would come into service during 1952.

Manufacture of the 100kW wind power generator was well advanced, but for reasons of convenience and economy, it was decided to erect it in the first instance at a site near the manufacturer's works. Its installation in North Wales will thus take place after a period of running under close supervision by the constructors.

The district heating scheme at the Westminster City Council's housing estate at Pimlico was in operation throughout the year, and at the end of the year covered about two-thirds of the ultimate number of dwellings in the scheme. Comprehensive tests were made on the two special turbines at Battersea power station which supply the heating steam, and on the main transmission pipes in the tunnel under the Thames which convey the steam to the estate. Measurements were also being made of the service performance of the distribution mains and the heat accumulator. The results of these investigations will provide data for a technical and economic assessment of the project.

The technical aspects of the Severn tidal barrage scheme for the generation of electricity are being reviewed in the light of the latest available information. A preliminary investigation is being made into three selected schemes of pumped storage ; these involve the use of steam plant at off-peak times, when the plant is not required for the public supply of electricity, to pump water from a low level to a high level, and the use of this water to generate electricity at times of peak demand by allowing it to return through water-turbines to the low level. It will be some time, however, before any of those schemes is developed.

A Dry Dock on the North East Coast

No. I

Reconstruction at the yard of T. W. Grøenwell and Co., Ltd., at Sunderland, has involved the building of a large dry dock, the lengthening of a second dry dock, and the extension of the fitting-out quay by 210ft. The new dry dock has a length of 675ft and can dock 32,000-ton tankers

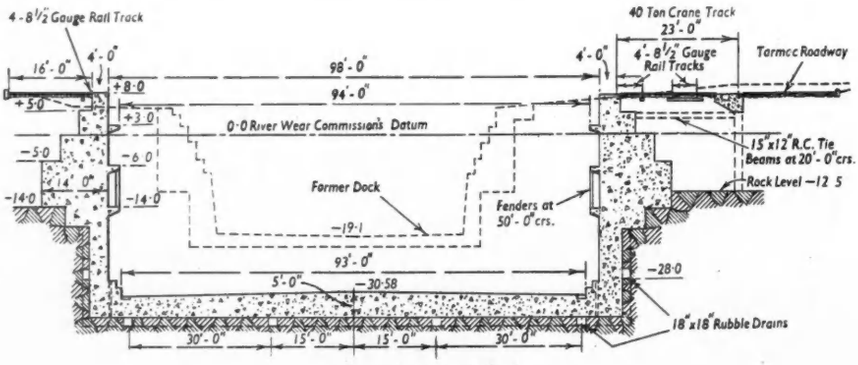
ON Friday, October 3rd, an extensive reconstruction scheme which has been in progress since the middle of 1950 at the ship repairing yards of T. W. Greenwell and Co., Ltd., on the River Wear at Sunderland, was brought to a successful completion with the official opening of two dry docks and a fitting-out quay. The No. 1 dock, although replacing a dry dock on the same site, built in about 1860, is, practically speaking, a new structure. It can accommodate tankers of 32,000 tons, and with one exception it is at present the only dry dock of its size on the north-east coast.

The dimensions of the No. 1 dock are listed in the accompanying table. The old dock which it replaces was damaged by enemy action during the war and has since been out of use. The company acquired additional land from the River Wear Commissioners to enable them to build the new dock, but even with this extra space the site is still a restricted one, and the dock extends from the river right up to the boundary fence. It is shown in cross section in the illustration below ; the cantilevered altars were used as a space-saving measure, as was the box gate, which is to be described in Part II of this article ; to give extra length at the head of the dock the original arch end wall was replaced by gravity walls tapering in plan from the full width of the dock to 10ft at the head, where a reinforced concrete wall 2ft 6in thick was constructed to span between them.

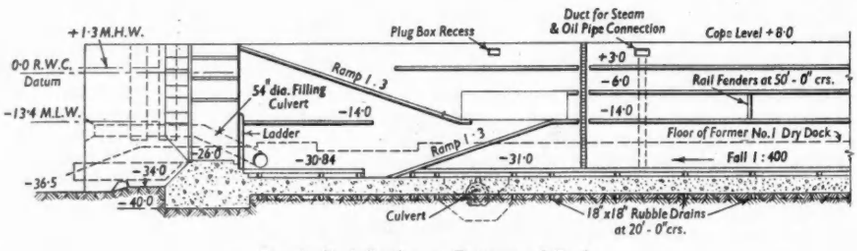
Principal Dimensions of No. 1 Dry Dock

Length	675ft
Width between fenders at entrance	87ft 6in
Width between copes	98ft
Depth over Sill at M.H.W.S.T.	27ft 4in
Total excavation	178,000 cubic yards
Total concrete	33,700 cubic yards

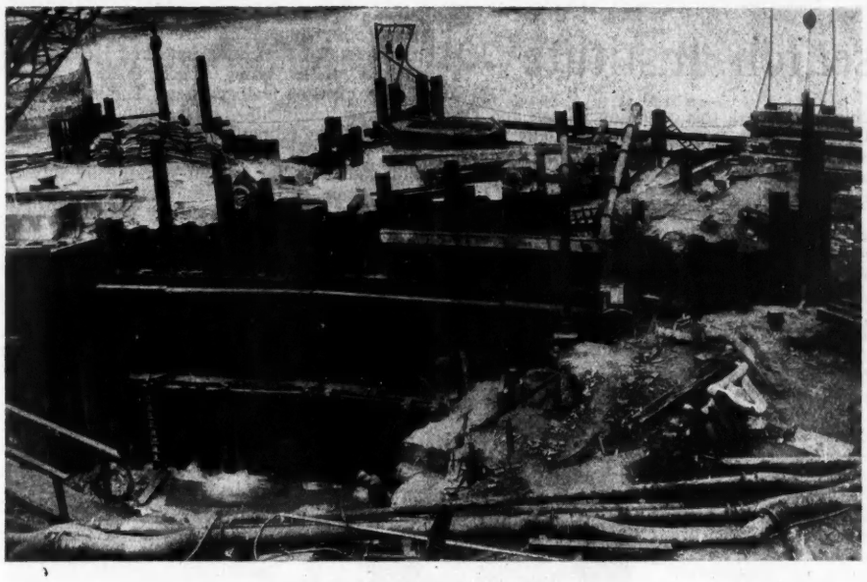
Not all the site was available when construction was started and the work had to be arranged



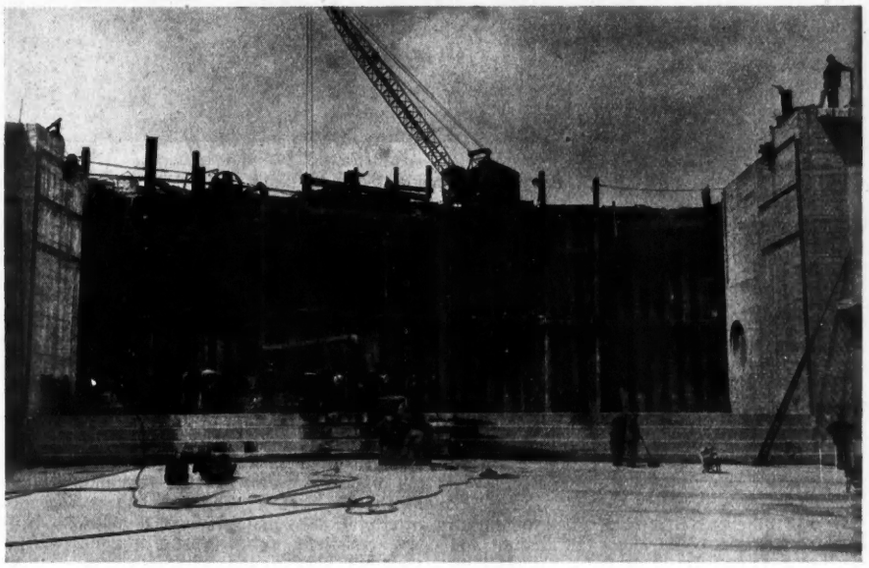
Cross Section of Dock



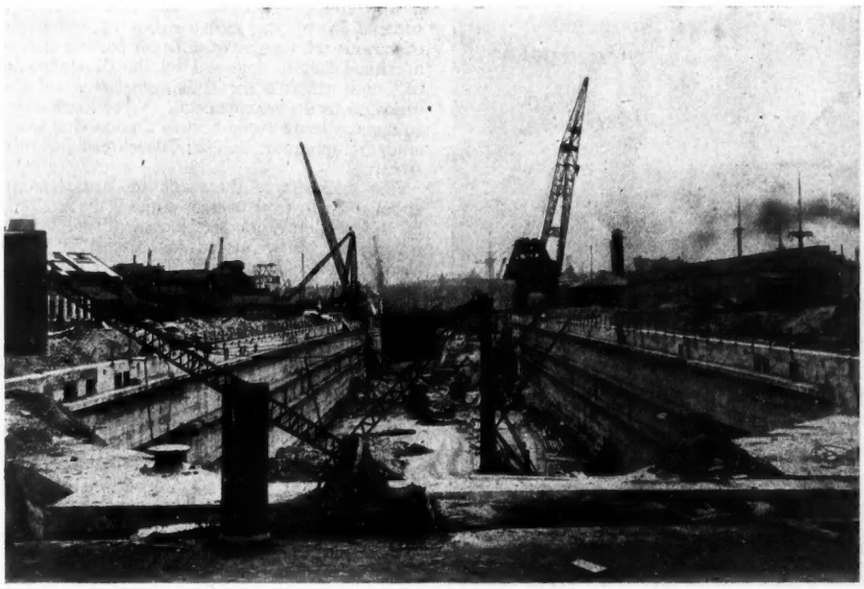
Longitudinal Section at Entrance of Dock



Gravity Cofferdam across Dock Entrance



Construction of Dock Entrance



Dry Dock Under Construction

accordingly. In the early stages the gates of the old dock were buttressed with reinforced concrete pillars and were then sufficiently watertight to enable construction of the walls and floor of the new dock to be started, whilst a cofferdam was being built in the tidal basin. Construction of the sill and entrance was then carried out in the dry under cover of this cofferdam.

Owing to the necessity of keeping the adjacent Sunderland South Docks continually open to shipping, an attempt was made to construct the south roundhead of the new dock first, inside a small, single-skin cofferdam. This method proved unsuccessful, however, and a modified form of construction was used incorporating a single skin of permanent sheet piling. The concrete of the roundhead was placed inside this wall of piling, some of the concrete being placed under water. Junction piles were incorporated in the permanent skin of piles and the piling of the principal cofferdam was subsequently closed on to these junctions.

The cofferdam across the dock entrance was of gravity design, consisting of two rows of Larssen No. 4B piles, 54ft long; the two rows were spaced 32ft apart, and the space between was filled with rock from the excavation. The two lines of piling were strutted and tied together at intervals with steel tie-rods. The space available for the cofferdam was again severely restricted, so that the movements of ships were not interfered with. On the north side of the dock the cofferdam abutted on to an existing river wall. However, there was considerable seepage into the dock from this side and a length of the side wall of the dock here was built behind a steel-sheet-piled cut-off. The cofferdam and the work at the entrance of the dock may be seen in two of the photographs reproduced herewith.

In the early stages of the work the dock walls were built in trench and the dumpling excavation removed subsequently. In the later stages, when access was obtained to the complete area it was possible to carry out all the excavation of a section before starting to concrete the walls or floor in that section. The sections of wall were generally 50ft long; the floor was constructed in blocks of 500 square feet maximum plan area. The walls were of mass concrete with 13·2 cubic yards of concrete per foot run of each wall, and the floor was 5ft thick in the centre and 4ft 6in at the sides. A typical cross section is shown in our first illustration. Water pressure beneath the floor and lower portions of the wall was relieved by a system of rubble drains connected to ball-type pressure relief valves discharging into drainage troughs on each side of the dock floor. The bulk of the excavation for the dock was in magnesian limestone, parts of which were treacherous owing to the presence of the "cannon-ball" formation peculiar to this district. To carry out the work use was made of a 40-ton dockside crane, built in position before the contract was let, and of numerous other items of contractor's plant. The design of the gate sill and part of the floor of the dock, showing the measures taken to carry the box gate, is illustrated in the second diagram. The illustrations on this page give a good idea of the construction work and site generally.

The existing pump house serving No. 2 dock was utilised for No. 1 dock. It was therefore necessary to build a culvert from the new dock to the old sump chamber. The culvert was built in tunnel and is closed by a greenheart sluice paddle operating between polished granite faces; the paddle is hydraulically operated with the cylinder situated in the shaft from which excavation and concreting of the culvert tunnel were carried out. The two dock pumps serving both the docks are each capable of discharging about 30,000 gallons per minute. For the new dock, however, an additional 10in diameter drainage pump has been installed and considerable modifications have been made to the drainage pumping system. A culvert has also been built from the new dock to the river, with a greenheart sluice paddle to control it, and with provision for stoplogs on the river side of this control. The usual services for ship repair are provided at the dock.

(To be continued)

The Fulmer Research Institute

AT Stoke Poges, Bucks, on Tuesday, September 30th, we attended an open day at the Fulmer Research Institute, which celebrates its fifth year of operation. Among the 500 guests of the Institute were many distinguished scientists and engineers, and the proceedings commenced with the unveiling, by Sir Archibald Rowlands, of a memorial plaque to the Founder of the Institute, Colonel W. C. Devereux, C.B.E.

The Fulmer Research Institute, Ltd., was officially opened by Sir Stafford Cripps on July 2, 1947, and a description of the establishment at that time appeared in THE ENGINEER, July 11th. Since then its yearly income has nearly trebled and the staff doubled and, on behalf of its sponsors, eighty-eight patents have been applied for and twenty-five scientific papers have been published by learned societies. It will be recalled that the Institute was founded to carry out sponsored industrial research and as such was largely an innovation in this country. The results of its work, including the patents, belong solely to the sponsors. No dividends are distributed to shareholders, and excess income over expenditure is used solely to improve its facilities.

The work of the Institute has remained largely focussed upon metallurgical research. The laboratory space for physical chemistry and colorimetry has since been increased and plans for housing the mechanical testing, creep and engineering laboratories in a separate building, are well advanced.

A very important aspect of its work relates to the reduction of such metals as beryllium and titanium and aluminium by distillation methods, and the development of pilot plant. Our illustration shows a pilot plant for the catalytic distillation of aluminium. It was explained by the Institute that following a consideration of spectroscopic data and observations on the distillation and subsequent condensation of aluminium in the presence of cryolite, Dr. Gross deduced that aluminium must form monovalent halides at high temperature and low pressure, and that the reversible reaction $2\,Al + AlX_3 = 3\,AlX$ (where X is a halide) could be used to distil aluminium by bringing the vapour of the trivalent halide in contact with the aluminium-bearing material at high temperature and low pressure and then cooling the resulting vapour of aluminium monohalide to condense the aluminium and re-form the vapour of the original trivalent halide.

To be commercially feasible, it is necessary for the aluminium and the halide to condense at widely different temperatures. If aluminium chloride is used, this condition is met, and Dr. Gross went on to prove experimentally that if aluminium trichloride vapour is let over impure aluminium a condensate of high purity aluminium can be obtained.

The process may be used for purifying scrap or aluminium of commercial purity, or for the extraction of aluminium from alloys produced by direct thermal reduction in the arc furnace. Further laboratory work is in progress under the joint sponsorship of Aluminium Laboratories, Ltd., and International Alloys, Ltd., and on the small experimental plant illustrated.

An indirect method of distillation is being investigated for the preparation of pure beryllium. By the intermediate formation of its stable halide, this element has been distilled at temperatures far below those at which its vapour pressure is sufficiently high for its direct distillation. The method displayed involved pressures as low as 0·1mm and temperatures in the region of 1100 deg. Cent. The method was said to be applicable to a wide range of other metals. Adjacent apparatus for the extraction and refining of titanium was exhibited, and the sponsor for this research was the Ministry of Supply. Details were not disclosed.

The " 500 " series of aluminium alloys which were developed at the Institute originated from a fundamental investigation into the mechanism of precipation hardening in alloys.

Typical properties of the aluminium/copper/cadmium alloy are as follows :—

	0·1 per cent proof stress tons per square inch	U.T.S. tons per square inch	Elongation per cent
Solution treated ...	7	18	35
Fully heat treated ...	27	32	10

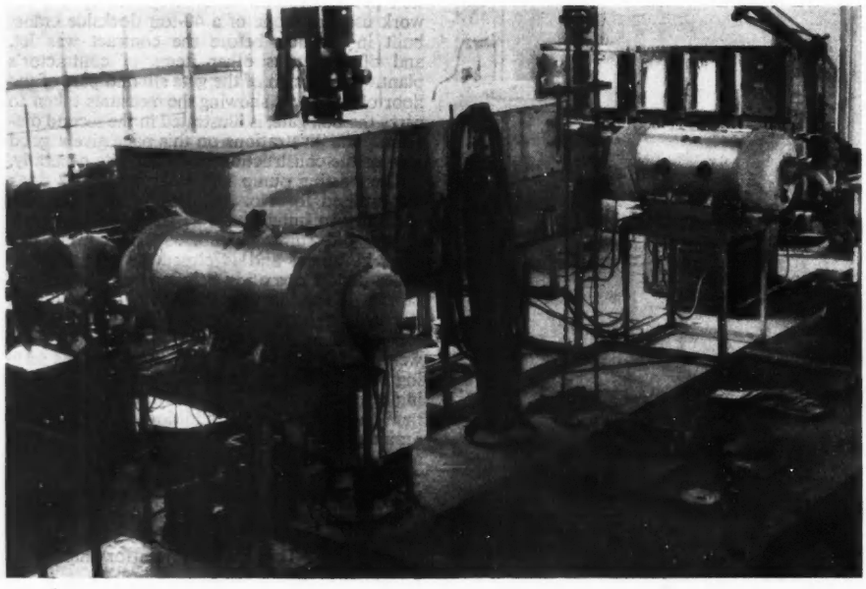
It was observed that very small quantities of third elements could affect the amount and rate of precipitation hardening in aluminium-copper alloys. Small quantities of cadmium added to aluminium/5 per cent copper alloy delay room temperature hardening after solution heat treatment, but accelerate and increase the amount of hardening which takes place at slightly elevated temperatures. The aluminium/copper/cadmium alloy in the fully heat-treated condition has properties at least equal to those of the normal duralumin-type, but shows a remarkable facility for hot working by forging or extrusion, and does not age at room temperatures after solution treatment. The alloy may, therefore, be fabricated more cheaply and at a greater rate than the conventional duralumin type. It is not necessary to carry out cold working operations such as bending and dressing immediately after solution treatment, or to refrigerate the alloy, as is necessary in the case of duralumin to avoid room temperature hardening. Development work is proceeding with various firms in the industry, in collaboration with the Ministry of Supply, who sponsored the original research work.

Forging, Extrusion and Sheet Applications of " 500 " Series of Aluminium/Copper/Cadmium Alloy

Another fundamental branch of its work has been sponsored by the National Gas Turbine Establishment, and it is concerned with the use of ceramic coatings for gas turbine components. In the particular case of the normal combustion chamber for these engines, distortion and cracking of the can forms a major limitation on the life of the engine. Ceramics can reduce this deterioration by first, its use as a coating having low emissivity properties to minimise flame radiation heating and secondly, as a coating also, to suppress oxidation.

The problems associated with each kind of coating are quite distinct. The development of a low emissivity coating was first developed successfully by the measurement of emissivity of various refractories of different particle size—a critical factor—followed by the development of bonds suitable for sticking selected refractories on to the parent metal. Vibration testing equipment using cyclic heating and cooling were amongst apparatus specially developed for this research.

The thickness of these coatings varies from about 0·001in to 0·008in. Among the exhibits in this section were test pieces of mild steel which had been exposed for several hundred hours to a temperature of 700 deg. Cent. An uncoated specimen had been totally oxidised, whilst the specimens coated with the most suitable ceramic were shown to be mainly unaffected by their exposure, although in some cases the coating had deteriorated. Some other uncoated specimens containing up to 5 per cent silicon, when similarly exposed, exhibited a resistance to corrosion equal to the better coated ones.



Pilot Plant for Catalytic Distillation of Aluminium

ENGINEER APPRENTICES.—Following a series of interview boards held in London, 200 youths have been accepted as apprentice engineers by the Anglo-Saxon Petroleum Company, Ltd. They will start the first stage of their career at technical colleges this month and under the new scheme the second stage will be spent at sea and the final period of twelve months will be passed at a shore marine engineering establishment to complete a training covering four and a half years.

Modernisation at Beckton Gasworks

The Beckton gasworks of the North Thames Gas Board is the largest works of its kind in the world and together with its chemical works, covers an area of about 540 acres. Since the war an extensive modernisation scheme to increase production has been combined with the reconstruction programme to replace the plant lost as a result of bombing. As part of this programme there have now been placed in operation a new carburetted water gas plant, a new boiler-house and a new workshop.

DURING the past few years an extensive programme of reconstruction has been in progress at the Beckton gasworks of the North Thames Gas Board to make good the losses and damage caused by enemy action during the war. This programme has been combined with a comprehensive scheme of plant modernisation and the introduction of new equipment of the latest design to give the increased production required to meet the growing demands for gas. An important stage in this programme was reached on Thursday last, October 2nd, when the official opening took place of a new carburetted water gas plant and a new boiler-house at the gasworks, and a new mechanised workshop and engineering stores in the adjacent products works.

The new carburetted water gas plant is housed in a large new building of reinforced concrete construction. This building, as can be seen from the photograph reproduced on page 498, is of clean modern design with large areas of windows which give excellent natural lighting within. The plant installed was supplied by Humphreys and Glasgow, Ltd., and consists of four single, automatically operated water gas generators arranged for back-run operation. It has a total daily capacity of 18,000,000 cubic feet of carburetted water gas at 500 B.Th.U. per cubic foot.

Coke is supplied to the plant by road vehicles, which tip their loads into a large boot serving each generator at the side of the building, and from this boot the coke is elevated to service bunkers above the generator by twin skip hoists. From the bunkers coke is gravity fed to the generators in metered quantities and on a preset time cycle by automatic chargers. Magnetic vibrating screens, which serve to remove small coke particles below 1in are interposed between the automatic chargers and the bunker feed chutes.

The generators have an internal diameter of 9ft and are provided with dry sealed Haug grates, which are designed to allow blast pressures of up to 60in water gauge to be employed. The grates extract the ash and clinker and deliver it into enclosed clinker pockets having sufficient capacity for eight hours' working between discharging operations.

Following each generator there are chequer-filled carburettor and superheater vessels, followed by a horizontal fire tube waste heat boiler. These waste heat boilers raise steam at 300 lb per square inch superheated to 500 deg. to 650 deg. Fah., whilst the annular boilers of the generators raise saturated steam at about 30 lb per square inch.

Provision is made for dust extraction by cyclones at the outlet of the generators and at the outlet of the waste heat boilers, prior to stack valves, which are enclosed and situated outside the main building.

The high-pressure steam from the waste heat boilers is supplied to an Allen pass-out turbo-generator of 1400kW capacity. This generator provides all the electric power to drive the air blowers, exhausters, pumps, and mechanical handling equipment in the plant, and a surplus for the works system. Steam passing out from the turbine at 15 lb per square inch flows through two steam accumulators, designed to smooth out the varying rates of steam production and demand, and thence to the process mains supplying the water gas generators at 7 lb per square inch. This supply is augmented by low-pressure steam from the generator boilers and the surplus from the coke oven producer plant. The steam system is balanced by the quantity passing to the condenser of the pass-out turbo-generator, which is automatically adjusted to the overall steam load conditions.

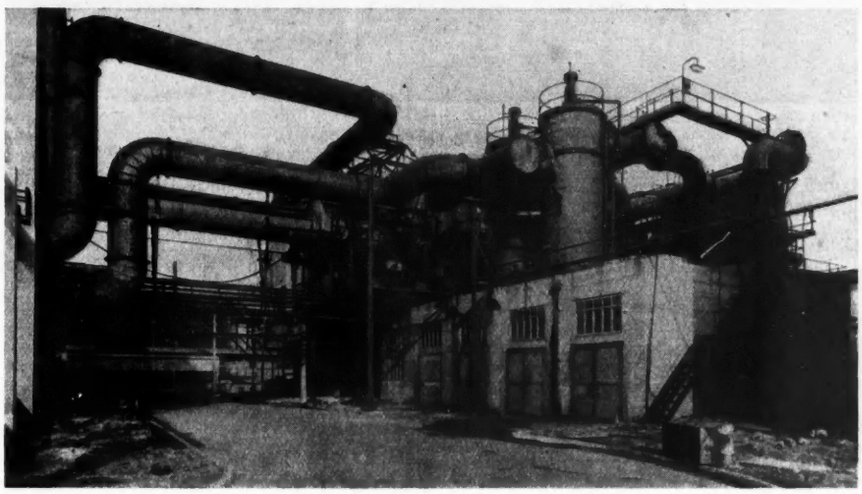
The plant, when producing its full 18,000,000 cubic feet of gas a day, consumes some 200 tons of furnace coke. From cold it takes about ten hours to get into full production, but it is normally kept under light load and can be stepped up to full production in less than an hour, if required.

A large new amenities block with clean and dirty clothes lockers and changing rooms, shower baths, canteen, &c., adjoins the new water gas plant.

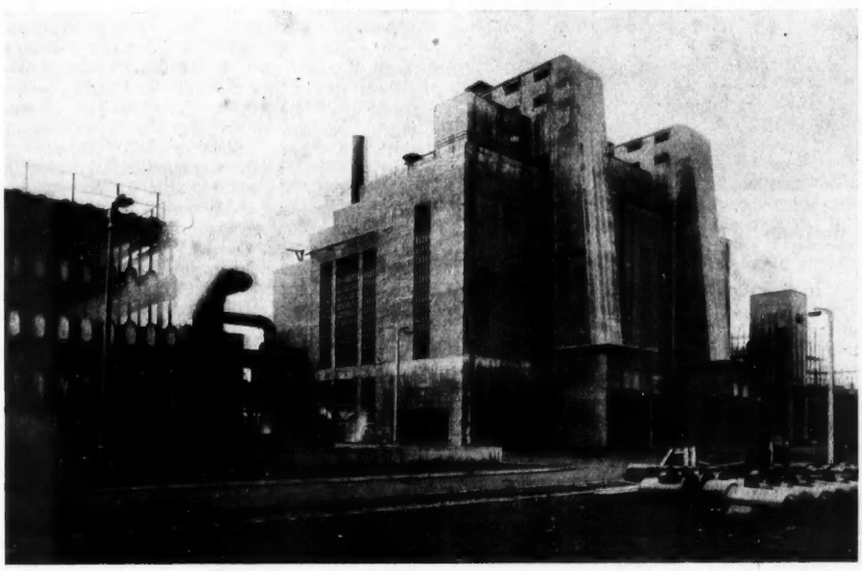
The increase in the amount of gasmaking plant in the works during recent years has had a natural result in increasing the demand for steam, and until the new boiler plant was introduced the position was not improved by the fact that one of the plants with twelve water-tube boilers had reached the end of its useful life. The new boiler plant has therefore been built both to replace old boilers and augment the general steam supply to the works. Four Babcock and Wilcox "C.T.M." water-tube boilers have been installed, and each of these units is capable of producing 40,000 lb of steam an hour at a superheater outlet pressure of 500 lb. per square inch and a final temperature of 750 deg. Fah. At present the boilers are operating with a working pressure of 300 lb per square inch and the high pressure will be used at a later date. Gilled economisers fitted to the boilers each have a heating surface of 5180 square feet.

The boilers, which are equipped with compartmental travelling grate stokers of 252 square feet area, have been specially designed to burn coke breeze. In order to reduce the high moisture content of this breeze and assist combustion furnace gases are recirculated through the incoming fuel bed by means of fans. Ash from the back of the boiler drops down a chute to a water quench, whence it is removed by a paddle ash extractor and deposited on to a conveyor belt leading out to an ash hopper. As in the case of the carburetted water gas plant, fuel is taken to the boiler-house by road vehicles and elevated from a boot by skip hoists to overhead bunkers. The two counterweighted skip hoists used each have a capacity of 30 tons an hour and the bunkers are designed to store enough coke breeze for forty-eight hours' steaming. Coke breeze is very abrasive, and in order to protect the metal of the feed chutes and distributors used to convey the breeze from the bunkers to the boiler stokers they have been lined with concrete.

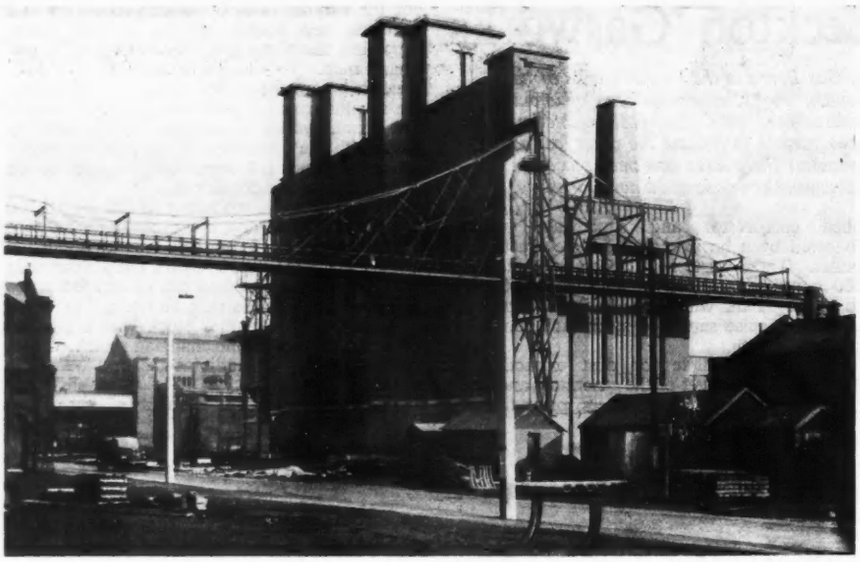
The four boilers are housed in the steel-



Carburetted Water Gas Ancilliary Plant



Carburetted Water Gas Plant



New Boiler House

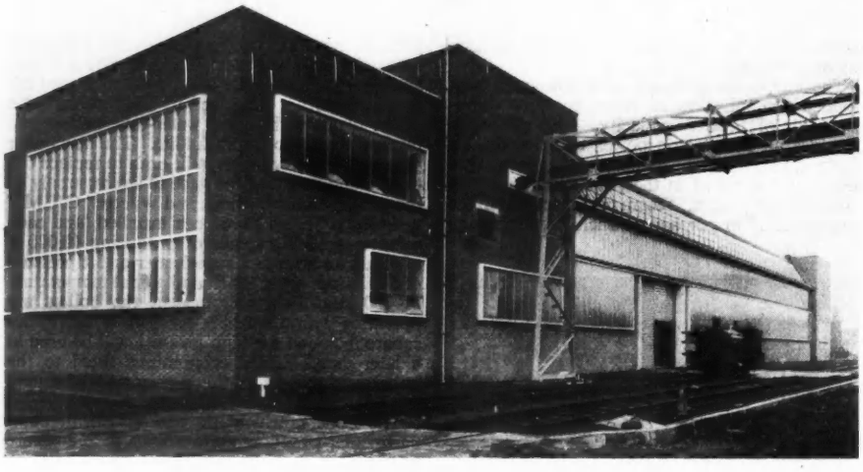
framed, brick-clad building, to be seen in the illustration above. This building was designed by the Board, and in the layout of the plant particular attention was given to providing adequate room round all the boilers and their ancillary plant to ensure ease of access to all parts for maintenance and inspection purposes. The bridge to be seen in front of the new boiler plant in the photograph is used to carry the mains for steam, water power and other service supplies round the works.

The new mechanical workshops in the products works take the place of a number of old, obsolete and scattered units, which have proved inadequate for the growing needs of the works. This products works receives the crude tar, ammonia liquor, crude benzole and spent oxide produced in the manufacture of purified town's gas from the carbonisation of coal from most of the stations of the North Thames Gas Board. It produces a very wide range of chemicals, fuels, &c., and is a self-contained unit with process plants provided with steam, electricity and other services from its own plants. The size of the works and the vast amount of process and service equipment incorporated make the inclusion of an efficient central mechanical workshop and stores in the organisation particularly necessary to ensure effective maintenance.

The new workshop has a floor area of some 80,000 square feet and consists of four main bays with gallery offices for administrative personnel and drawing-offices at one end. In addition to a machine shop, pipe shop, boiler shop, electricians' shop, &c., a large area of the new building is laid down to accommodate the engineering stores. Three of the main bays are served throughout their length by overhead travelling cranes. There is a large unloading dock at one end, and a set of rail tracks which passes across the width of the bays can be used for the transport of heavy units to and from the shops.

The building is a steel-framed structure, carried on reinforced concrete piles and having north-light roofing supported on steel stanchions, which also carry the beams for the crane rails. The north-light roof and ample wall glazing give good natural lighting in all parts of the building, whilst the artificial lighting is designed to give a minimum of about 12 foot-candles over the full floor area. A point of interest is that the steel roof structure has been so designed that all surfaces are fully accessible for painting. This precaution was considered essential owing to the corrosive nature of gasworks' atmosphere.

The installation of all the machine tools and equipment is not yet completed, and when the full plant is in operation the shop will be responsible for the general maintenance of the products works as well as of the Board's manufacturing stations.



New Mechanical Workshops

Refuse-Sewage Composting—Engineering Aspects

By HAL GUTTERIDGE, M.I.Mech.E., M.I.E.I.

This paper, read before the Society of Engineers on October 6th, and here abstracted, deals with the modern plant and equipment necessary for the composting of town refuse and sewage to form an organic manure. The growing realisation of the need of the soil for an organic manure, if it is to be kept healthy under existing high crop extraction, has led to great interest in the utilisation of these valuable wastes. Composting will absorb considerable quantities of sewage sludge and therefore will, in future, affect the size and disposition of sewage works. It will also concern the disposal of town refuse.

AMONG the many reasons for the infertility of the soil resulting in soil erosion, is the fundamental one of the loss of humus. This formerly was "made up" from farmyard manure but, with the increasing crop demands on the soil and the decreasing number of farmyard animals, the deficiency has arisen. Fortunately, at hand, are materials which, when properly processed, can contribute toward counteracting this deficiency; these materials are the habitation by-products of town refuse and sewage which, by the process of composting, can be converted into an organic manure to supply the humus which is essential to the needs of the soil. From time immemorial man has recognised the value of returning to the soil his habitation by-products as the best protection against disease by insects or fungi. The increased interest in the subject of supplying organic manure to the soil is the slow realisation that the land, by being deprived of the necessary plant food to replace that which has been removed by harvesting, is gradually becoming devitalised. It is only by making good this loss with the humus or organic manure in combination with inorganic fertilisers that its health can be restored and maintained.

DISPOSITION OF COMPOST PLANTS

There is a variety of systems in which the process of converting town refuse and sewage into an organic manure are carried on. The choice is one which can only be arrived at after full consideration of the particular conditions obtaining in the area to be served.

In cities and towns there are mainly two systems used in practice: (*a*) the system in which the refuse, separated and pulverised locally in one or more pulverising plants, is then transported to the composting plant, or (*b*) where the refuse separated or otherwise is taken to the composting plant outside the city limits, at which place is carried out the remainder of the processes.

A composting plant may be situated at or near the sewage works where the land is more likely to be obtained for the maturation of the composted materials and also because sewage sludge and screenings are available. Alternatively, the composting plant can be elsewhere and the sewage sludge pumped to it or the dried sludge transported thereto. In Southwark, London, is an example of the system (*a*) described above, which has been in operation for a number of years. At that station about 20,000 tons of crude refuse per annum are handled; the saleable materials and those unsuitable for composting are abstracted and the materials for composting are pulverised. A portion is transported by rail to the Northern Outfall Works of the London County Council in Essex on the River Thames, where it is composted with sewage screenings.

An example of the system (*b*) is in Holland where, on a country-wide basis, the crude refuse from a number of cities and towns is transported by rail to a central composting plant in a part of the country which requires the organic manure. In that country, that system has been put into practice on a large scale where 125,000 tons per annum of crude refuse are sent from the Hague in the west, 30,000 tons per annum from Groningen in the extreme north-east and also from other towns, to a central composting plant at Wyster, in the north-east of Holland, which plant produces some 120,000 tons of compost per annum, as described by Westrate.

Much pioneering work in composting has been carried out over a considerable number of years

in many countries, as in England, at Leatherhead for twelve years, Maidenhead for thirteen years ; in South Africa for ten years and in New Zealand for four to five years and on a large scale more recently in Holland, to name but a few. This has led to the increase in the knowledge of the methods of treatment to achieve the best results in producing a high quality organic fertiliser at a reasonable cost. The need for increased food production in 1940 led to the initiation by the Agricultural Research Council in England of a programme of research into the problem of using habitation by-products—town refuse and sewage sludge—as a source of organic manure.

The composting of waste and sewage sludge or sewage screenings is of particular interest to the sewage disposal authority for by this means a substantial proportion of the sewage sludge received could be absorbed in the compost. The future distribution, number and capacities of sewage disposal works would be affected by this development in composting. The processes of sewage treatment would be partially simplified and re-oriented to the useful purpose of returning to the soil the habitation by-products—refuse and sewage—to make up the loss to the soil by the harvesting of crops.

Conversion of Habitation By-Products into an Organic Manure

Equipment.—The equipment required in the conversion of habitation by-products into an organic manure within the general conditions stated in this paper, is set out under the following headings :—

(*a*) Reception of refuse.
(*b*) Separation of salvable materials.
(*c*) Pulverising of materials for composting.
(*d*) Aeration cells.
(*e*) Maturative beds.

Generally.—The amount of mechanisation should be the maximum within practical and economical limits with a view to reducing manual labour to a minimum as the work is heavy and as the operational cost must be kept low. Essential plant should always be in duplicate as an insurance against breakdowns causing interruption of the processes, as the refuse arrives regularly and has to be dealt with without delay.

Comparison of Systems

Reception of Refuse.—The refuse may arrive in quantities up to 4 or 5 tons per vehicle and as fast as the vehicles can deliver and be driven clear. The first reception arrangements must therefore be such that the incoming vehicles can be " cleared " in the minimum of time and the capacity of the reception hopper be sufficient to receive the material at the rate it arrives without becoming over-full.

One form is to have a hopper with a variable speed steel slat conveyor at the bottom delivering the crude refuse under an adjustable bridge to a conveyor belt which elevates it to the rotary screen. A ramp may be arranged for the vehicles if it is undesirable to excavate for the hopper. With an end-discharging vehicle, it is usually necessary for the vehicle to manœuvre into position for delivering its load, but this can be obviated by arranging for the motorised vehicle to pass right over the hopper ; the wheels being guided by suitably arranged floor guide-rails. It is convenient to have the hopper and elevating belt within a building so that arrangements can be made to extract the airborne dust. This may amount to 2 cwt per 100 tons of refuse. Arrangements can be made to add this dust to the shredded material in the aeration cells, if desirable.

Separation of Salvable Materials.—The rotary screen or shaker screen conveyor usually is composed of ½in wire mesh in the first half and 1½in mesh in the second half, for the extraction of dust and cinders, respectively.

Arrangement can be made to pass on a portion of or the whole of the dust to join the materials in the aeration cells if required. The cinders drop into a hopper, from the discharge doors of which vehicles are fed direct by gravity. Alternatively, to save the organic matter dropping through with the cinders, the material can be arranged to drop on to a short conveyor with an adjustable transverse slope ; the cinders bouncing off to the hopper and organic matter remaining on the belt to rejoin the main flow. The material from the end of the screen may be discharged direct on to a " picking belt " and passed under an overband or other type of magnetic separator to take out tins and other pieces of ferrous metal. From the picking belt are removed, by hand-picking, the salvable materials, such as clean paper, wood, rubber, leather, glass, non-ferrous metals ; the tins and paper are fed into baling presses and other salvaged materials into suitable hoppers. Also any other materials unsuitable for passing on to the subsequent processes are picked off. This equipment, together with the pulverising units, is preferably placed within a building.

Pulverising of Materials for Composting.—The picking belt delivers the material direct into one or more pulverising machines, which usually are of the free-swinging hammer type. The purpose of these machines is (1) so to break up the vegetable matter that it will facilitate fermentation (2) to reduce the materials so that they will pass through a 2in screen to form a homogeneous mass, (3) to provide more available surface area for the organisms to work on, and (4) to re-distribute the moisture content throughout the mass.

The pulverising machines may deliver on to a cross-belt with a drum-type magnetic separator to remove any ferrous metal still present. This cross-belt may discharge on to a belt conveyor which delivers the material to the aeration cells by a travelling throw-off carriage. To this may be added a radial belt extension mechanically to spread the material in the cells, with the sludge delivery coincident therewith.

The general layout arrangement would be varied *inter alia*, to suit the capacity needed, the composition of the refuse, the type of treatment, the degree of mechanisation, and whether the material is to be pulverised at the local plant or to be composted as well in the same works. On small combined pulverising and composting works, for instance, the incoming material may be tipped direct on to a grid from where it is forked by hand direct into the pulveriser, the dust and ashes having passed through the grid and the refuse having been rough hand-picked. In that case, the pulverised material may be elevated and delivered over a magnetic pulley into a mixer in which sewage sludge is introduced, and discharged into hand trucks on rails below for distribution to any of a number of aeration cells within the building. In Auckland, New Zealand, the pilot plant operated, through centralised controls, by one man handles 10 cubic yards of refuse per day, representing the refuse from a population of 750 persons.

In a large capacity plant for pulverising only, the pulverised material can be discharged directly into slowly or intermittently moving railway wagons, with suitable distribution arrangements for completely filling the wagons, or the road vehicles, as the case may be, for the transport of the material to the composting works.

Aeration Cells.—Among the conditions to be achieved to promote the most active conversion of the material are :—(1) the optimum oxidation with production of heat, which requires the material to be properly crushed by the pulveriser ; (2) the provision of a sufficient supply of air throughout the heap of the material so that vigorous bacterial and fungal growth can take place ; (3) a prerequisite condition for the growth of micro-organisms is that the material in the cells shall be damp but not water-logged, which implies a properly maintained supply of moisture, with adequate draining ; (4) the handling of the material in the cells so that it will not be consolidated and so prevent the air supplied from underneath and surrounding the heap from penetrating the mass as freely as necessary.

The University of California, in stating that aerobic composting with the absence of odours and more rapid decomposition seems to be much superior to anaerobic composting which results in odours and nuisances and much slower decomposition, reports that temperatures of about 75 deg. Cent. (167 deg. Fah.) are reached within one day after the material is prepared for composting, but the most rapid composting seems to take place between 60 deg. Cent. and 70 deg. Cent. (140 deg. Fah. and 158 deg. Fah.).

The number of cells may be based on the number of working days per week and the period of time necessary for the materials to remain therein. As an example, if the refuse is delivered six days per week and the materials remain in the cells for fourteen days, then twelve cells would provide the cycle of rotation, with one cell each for filling and emptying, making fourteen cells in all or any multiple thereof, if one day's output is too much for a cell of a convenient size. The cells can be made of concrete with walls about 6ft high and floors arranged for controllable drainage, and aeration from below if required ; the supply of air at low pressure being at floor level so as to permit the further aeration of fermenting material. The sewage sludge, in measured quantities, is introduced by spraying, through piping or from gutters, or if sewage screenings are used, by jib crane grab or other means.

With the object of obtaining a continuous flow instead of " batch " progress of the material, an alternative is to have two long cells side by side, each with a capacity of, say, one and one-half week's output. The sludge would be sprayed on during reception of the pulverised refuse in the cell, and later, if necessary. The deposited material may be " turned over " within the cells and finally delivered over the side to a conveyor leading to the maturative beds by a mobile spiked belt conveyor to " eat " into the material and deposit it at a higher level behind, or by mechanical shovel. This " turning-over " action should take place contemporaneously with the reception of the material, with the necessary " lag " of up to five days to allow for initial fermentation. Other proposed equipment is a travelling crane with traversing carriage with a plough to " turn over " the fermenting material in a long cell. In the University of California, it was found that composting is more rapid if the material is " turned over " at least every other day in the early stages of decomposition to provide aeration and to prevent the compost piles from becoming too hot. In the later part of the composting period less frequent turning over, if any, is required. The depth of the material in the aeration cells is usually about 5ft which, with aeration from below and draining, allows the first part of the process of oxidation and fermentation, without putrefaction, to be completed in about fourteen days, with a further three or four months on the maturative beds.

A proposed plant in America based on the " Verdier " process with a designed capacity of 900 tons of refuse per day has very deep cells which, when fully charged with pulverised material and inoculated with liquid, are closed and not re-opened during the eighteen to twenty days period of fermentation. Air is circulated continuously through the mass, and ventilation and drainage are maintained during this period.

In the " Beccari " process, a closed cell is provided with valves which serve to exclude air during the first stage which is anaerobic. When the maximum temperature of about 65·5 deg. Cent. (or 150 deg. Fah.) is reached in about eighteen days, the valves are opened and air rushes in, induced by the shrinkage of the mass. The total retention period is from thirty-five to forty days. An improvement on this process was made in a plant at St. Georges, France, where air was added to the cells during the fermentation period. This project comprised forty cells, each with 700 cubic feet capacity, which were set 10ft above ground to facilitate the removal of the fermented material ; the digestion period was twenty days. Another example in the application of the " Beccari " process was at Geneva, Switzerland, where, instead of a number of cells, one hermetically-sealed tower, with a capacity of over 56,000 cubic feet, was filled from above and emptied from below. Air was introduced at a pressure of 7 atmospheres and the fermentation period was thirty-five days.

The amount of aeration from below is a matter which depends upon the material to be composted. Bould found that aeration from below, using the heat of decomposition to draw air through a perforated bed which also provided drainage, was a very distinct improvement. With such aeration, a uniform high temperature developed throughout the compost reaching a peak value of approximately 65 deg. Cent. (149 deg. Fah.), on the sixth day after turning. Compost without

aeration from below took ten days to reach a peak temperature of about 50 deg. Cent. (122 deg. Fah.). The initial moisture content in each case was 60 per cent of the fresh weight. At the other extreme, Vick found that, in heaps 4ft high supplied with air at a pressure of 7 lb per square inch, no rise in temperature was noted after one week, and it was assumed that an excess of air had been used, whereas in heaps of similar height with no forced air but with natural ventilation arrangements, a temperature of 61 deg. Cent. (141·8 deg. Fah.) was realised after eight days with a mixture of pulverised refuse and sewage screenings.

Mixing Refuse and Sewage Sludge

The method of introducing a liquid into the pulveriser with the refuse is established in the U.S.A. in garbage grinding for disposal of refuse through the sewers. The continuous mixing of the two materials in a ribbon or screw trough-mixer has been suggested but the abrasive content of the refuse, such as cinders, would reduce the normal life of the mixer. A cascading cylindrical mixer with lifting paddles arranged on the inside of the drum and the sludge brought in with the refuse or sprayed into the cylinder, in their proper respective quantities would possibly have the disadvantage of inducing "balling up" of the mixture. This would produce conditions in which the mixture would not readily discharge itself.

It would appear that the best place for the mixing of the refuse and the sewage sludge (or sewage screenings), to produce the optimum aerobic conditions for rapid bacterial and fungal development, is in the aeration cells for: (1) the pulverised refuse readily absorbs liquid when lightly stacked; (2) the material acts as a filter to retain the solids in the sludge; and (3) the condition within the cell—because of adequate draining—remains aerobic.

Many attempts have been made to produce an effective and economic continuous process for composting. In the "Earp-Thomas" process, the seeded material is agitated by means of ploughs in a specially constructed composter; the digesting material moving in a special path counter-current to a stream of heated air.

In the "Fraser" process, the atmosphere obtained from the digestion cell itself is forced through the material. This system is thoroughly mechanised and includes continuous agitation; a retention period of five to seven days is claimed with complete stabilisation in that period. There is one demonstration plant at Chicago Union Stock Yards with a rated capacity of 50 tons per day of manure.

The "Dano" process, which is in use in about twelve Danish and Swedish communities, is highly mechanised with a retention period of some twelve hours. The refuse and sewage pass through two horizontal rotary drums operated in series. The digesting material is broken up in the first and undergoes final stabilisation in the second, passing out through sieves when the particles become sufficiently reduced in size. Specially treated night soil or sewage sludge is used.

Maturative Beds.—The material is received from the aeration cells either by overhead travelling jib-crane grab or through a removable portion in walls of cells by mobile shovel or by other means and taken to the maturative beds.

In order to minimise the loss of nitrogen as ammonia, the maturation phase may be carried out under anaerobic or partly anaerobic conditions in covered storage. If the material is in the open, it should be in large heaps about 6ft high, where it is left to mature. Covering of the heap is an advantage to reduce the loss of nitrogen when it becomes available and leachable.

There are various tests to indicate when the material is mature. The criterion as to whether a material is ready for plant food is mainly judged by the ratio of the carbonaceous to the nitrogenous matter. In the New Zealand inter-departmental second report, some approximate C/N ratios are given, such as farmyard manure 14, dried blood 4, cabbage 12, flax waste 58, wheat straw 128, raw sawdust 510. It is pointed out that these are variable but they serve to indicate the necessity of the composting of the higher C/N ratio materials to bring down the ratio to the point where, if used as a manure, they would not be likely to abstract nitrogen from the surrounding soil but to release their nitrogen to the plant. Bould states that storage should be continued until the tests for maturity show that nitrogen immobilisation in the soil will not occur, and Professor Stoughton says that investigations have shown that the critical point for materials of this type is when there is a ratio of the order of 20:1 of "available" carbon to "available" nitrogen. As in crude refuse, the C/N ratio is usually between 25 to 30 : 1 (both figures corrected for "availability"), it will be seen that it is harmful to apply crude refuse to the land as a manure. Professor Stoughton also adds that, if the material is stored too long, the fermentation leads to decomposition of much of the carbonaceous material and a gradual lowering of the C/N ratio to a final value of 12 : 1, which is wasteful, as much of the dry matter is lost.

At the municipal compost plant at Dannevirke, New Zealand, the whole process of composting of refuse and sludge takes six months and the material is then found to be full of earthworms. The presence of earthworms within the heaps and toadstools on the surface are valuable indication of approaching maturity. Earthworms contribute by aeration of the heap and by passing the material through their bodies. Toadstools (which appear in prolific numbers at Dumfries) are stated to be of value in storing nitrogen.

Time for Maturation

Burke gives the time for maturing only as twelve weeks, but preferably twenty-two weeks. Bould gives the time of two to three months storage as necessary before application to the land.

As the refuse is received regularly day by day but the manure is only applied to the land in the winter and spring, storage is necessary to accommodate the material produced in the summer months. This congestion in stocks is partially relieved by the fact that the amount of refuse is considerably less in the summer and horticultural and market gardeners and particularly those cultivating under glass, give some demand in the summer months.

After the material is matured, it is usually put through a vibrating screen and the large lumps crushed. It can then be elevated to overhead hoppers and bagged or loaded direct into rail or road vehicles.

Economic Comparison of Methods of Disposal

The same quantities of refuse and sewage have to be handled whether refuse is disposed of by tipping or incineration and the sewage by dumping at sea or whether they are utilised by composting into an organic manure.

In respect to refuse, the same number of collecting vehicles, the equivalent labour force and a similar number of collecting stations are required. When the refuse is separated and pulverised at the collecting station, its weight will be substantially reduced by the extraction of the saleable and other materials, therefore only the remaining portion of the weight of the crude refuse has to be transported to the composting works, the salvaged materials being sold locally where the market is situated. As a result of the pulverisation of the remaining material, putrefaction does not take place and therefore the risk of infection from flies and other vermin is removed as the vermin are not attracted to the refuse in the pulverised condition; the refuse is in a state not offensive to human touch or smell. Being pulverised and homogeneous it can be conveniently handled in bulk in railway wagons or in barges in contra-distinction to crude refuse.

In regard to sewage, its delivery to the sewage treatment works is the same whether it is to be utilised or otherwise. In composting, a substantial proportion of the total sewage sludge could be dealt with when all the refuse is being converted, thus one side of the treatment load of the sewage works, i.e. the sludge treatment, would be reduced considerably. The cost of transporting all the refuse, or the remainder after the salvaged materials have been extracted, to the tipping place, would be credited to the composting system less the cost of transporting the pulverised material after salvaged materials have been extracted.

When tipping areas are filled up or too far away, then composting becomes a competitor as a means of disposal only, apart from the utilisation of the compost. In composting, the value of the end-product—humus fertiliser—will be credited, whereas in "tipping" the material has little value, i.e. that in raising the level of low ground. Likewise, sewage dumped in the sea does not bring a monetary return.

On capital costs, new pulverising and compost plants have to be built and the interest and amortisation charges would be allowed for but, because the amount of the sewage to be treated at the sewage works would be reduced, future capital savings would accrue which would be credited to the composting system. The land released by the less extensive sewage works could be used for composting or the value credited to the composting system.

With the limited experiences so far available, it is impossible to be dogmatic in a comparison of costs between the normal methods of refuse and sewage disposal on the one hand and a system of composting on the other. If the latter proves to be moderately higher, the gain in soil fertility should not be forgotten.

132kV Pipeline Compression Cable in S.W. Scotland

Two of the four 50MW sets in the new Braehead power station, 4 miles down the Clyde from Glasgow, are now in operation and the 132kV Enfield cable from Braehead to Govan was commissioned early in September and is under load. Between Braehead and Govan, a distance of some 5500 yards, there is an Enfield 0·5 square inch, three-core pipe-line compression cable operating at 132kV. The single core cables are contained in a steel pipe 6⅝in diameter and operate under a working pressure of nitrogen gas at 200 lb per square inch. Toward the end of the pipe-line the cable trifurcates to three self-contained single-core compression cables, which are terminated by sealing bells with stabilised glaze.

The second part of the Enfield contract comprises two 0·3 square inch compression type 132kV cables and auxiliaries, now being laid from Govan to Haggs Road, Pollokshaws, a distance of 4500 yards. The cable is of similar construction but the pipe diameter is 5½in. This part is nearing completion and it is expected to be under load at the end of the year, when it will take some of the load of Dalmarnock power station while a section is shut down for renewals.

Technical Reports

National Building Studies Special Report No. 15: "*A Survey of the Behaviour in use of Asbestos-Cement Pressure Pipes.*" D.S.I.R. London: H.M. Stationery Office. Price 2s. 6d.—The British Standard, No. 486, for asbestos-cement pressure pipes was published in 1933, and since that time, asbestos-cement pressure pipes, usually coated internally and externally with bitumen, have come to be used widely. The Building Research Station has completed a general survey of their behaviour in use, the results of which have now been published in this report. The survey is based on consultation with some seventeen users, mainly local authorities, and on the examination of samples of pipes and joints which have been in service for varying periods of time and under varying conditions. It covers the use of pipes in various kinds of soil, both corrosive and non-corrosive, and their behaviour in carrying corrosive and non-corrosive waters has been studied. The mechanical behaviour of the pipes, including their susceptibility to damage in transit, on the site and in service, has also been studied, and the qualities and behaviour of various types of joints used with the pipes have been considered. It is established that over the period of use—up to seventeen years—for which experience is available, pipes of this sort behave satisfactorily in most soils, subject to suitable precautions being taken, and can provide a satisfactory substitute for iron pipes, although their strength in bending is not as great. An appendix to the survey deals in detail with the examination of samples of asbestos-cement pressure pipes after use, and the publication is illustrated with photographs showing the condition of pipes and joints after use.

Industrial and Labour Notes

Northern Productivity Exhibition

A Northern Productivity Exhibition is to be held in the Baths Hall, Northumberland Road, Newcastle upon Tyne, from October 30th to November 6th. It will be opened by Mr. Duncan Sandys, the Minister of Supply. The Northern Regional Board for Industry is sponsoring this exhibition, the arrangement of which has been undertaken by a planning committee under the chairmanship of Mr. R. W. Mann, the immediate past-president of the North-East section of the Institution of Production Engineers.

The theme of the exhibition, it is stated, is the productivity progress which can be achieved through the co-operation of management and workers. It will endeavour to show how ideas at work, good planning, efficient methods, simple adaptations and plain commonsense can contribute to greater productivity and to the general well-being of industry and the nation. Many local firms are contributing to those sections of the exhibition which will demonstrate how the engineering industry is tackling productivity problems. One section will deal with work study, another with costing methods and production control, and a third with welding. Other parts of the exhibition will emphasise the important contributions made to industrial progress as the result of education and University research. These displays are being organised by King's College, Newcastle upon Tyne, and the technical colleges within the region.

Questions on Commercial Practice

Specific inquiries related to commercial practice, and covering such matters as distribution, finance, accounting, &c., are now included in the "technical questions and answers service" sponsored by the Mutual Security Agency. This new aspect of the service is being handled in the United Kingdom by the British Institute of Management and the Association of British Chambers of Commerce. In the first instance, these two bodies draw on their own and other British sources of information, but questions that cannot be answered by those means are passed to the Board of Trade for transmission to the office of technical services of the United States Department of Commerce.

A condition of the service is that answers shall be circulated to all member countries of the Organisation for European Economic Co-operation, although, of course, the name of the inquirer is not made public. The questions with which the new service deals are those on such matters as training courses for salesmen, systems of internal financial audit, management controls, sales organisation and control, sales statistics, market research, costing, credit control, punched-card accounting, insurance practice, inventory valuation, and work measurement.

Questions can be submitted through local Chambers of Commerce affiliated to the Association of British Chambers of Commerce, or they may be sent direct to the British Institute of Management, 8, Hill Street, London, W.1.

"Danger Figures for Production Management"

The British Institute of Management has issued a booklet entitled *Danger Figures for Production Management*, the purpose of which is to offer suggestions as to how general managers of smaller manufacturing undertakings can keep themselves informed about the day-to-day performance of plant. The various chapters of the booklet deal with such matters as measurement of overall productivity, causes of lowered efficiency, and standards of performance.

It is suggested that effective control is often weakened by the gap that exists in many companies between the general manager's daily impressions and the financial figures which, when they become available, may, or may not, confirm those impressions. The booklet, therefore, gives examples of a few simple control figures that react visibly to a fall in performance. Some of these suggested control figures afford comparisons between two periods, and others between actual performance and previously set standards. Particular attention has been given to a discussion of methods of setting such standards, and their value and uses as yardsticks in production planning, price estimating and in planning incentives.

The booklet, which is 3s. 6d., is obtainable from the British Institute of Management, 8, Hill Street, London, W.1.

Training for Foremen

The Institute of Industrial Supervisors has published some particulars about the short residential courses for foremen and supervisors which it has organised in recent months, and about its plans for the extension of the courses. In arranging the courses, the Institute has had the full co-operation of the department of industrial administration of the Birmingham College of Technology. The subjects chosen for study during the courses were designed to be of direct help to foremen and were planned to promote the exchange of experience by the discussion of case studies and by practical exercises and demonstrations.

Four residential course programmes have now been developed, dealing with the practice of supervisory management; human relations, communication and discipline for supervisory management; work study for supervisory management; and industrial relations and industrial law. The intention is to repeat these programmes at residential centres throughout the country at regular intervals during the remainder of this year and in 1953. It has been found that to obtain the maximum benefit from discussion during the courses, attendance should be limited to thirty students of similar experience and responsibilities, although they may be drawn from different industries. In order to assist particularly medium-sized and smaller firms, the courses are arranged for week-ends. Full details and dates of forthcoming courses are available from the Institute of Industrial Supervisors, Bank Chambers, 47, Temple Row, Birmingham, 2.

Iron and Steel Production

The output of steel ingots and castings in Great Britain during September averaged 329,800 tons a week and was thus at an annual rate of 17,149,000 tons. The highest rate recorded previously in September was 16,964,000 tons in 1950. Taking the first nine months of this year, steel production has been at an annual rate of 15,772,000 tons, compared with a rate of 15,628,000 tons in the corresponding period of last year.

Commenting on the September figures, the British Iron and Steel Federation says that the new record has been made possible by the expansion of pig iron production which has been greatly assisted by the coming into operation of four new blast furnaces in recent months. These furnaces, which have taken on the average about three and a half years to build, were part of the industry's 1946 development plan. Pig iron production in September was also at a record rate. It averaged 208,600 tons a week, which represented an annual output rate of 10,845,000 tons, compared with a rate of 9,854,000 tons a year earlier.

Export Prospects

At a meeting of the London and South Eastern Regional Board for Industry, which was held last week, one of the principal items for discussion related to developments in the export market. It was stated that manufacturers of engineering products in the region had reported a loss of export orders because of the long and uncertain delivery dates which difficulties with raw material supplies and sub-contractors had compelled them to quote. Complaints from overseas had been received about the failure of United Kingdom firms to provide good after-sales service and their inability to supply spares for immediate delivery from stock. It was added that steel-using firms in the region were pinning their hopes for improvement on recent Government promises of increased steel supplies for export use.

Further news about overseas markets was given at the meeting by Ministry of Supply representatives, who said that the great need for increasing exports had led the Ministry to approach certain engineering firms to see if any immediate improvement could be obtained in their already considerable export business. Inquiries from industrialists who required any assistance, either for establishing or increasing present exports, would be welcomed by the Ministry. A report from the Admiralty, which was presented to the meeting, indicated that the re-organisation necessitated by the first impact of the defence programme had now been effected, and apart from certain specifications of steel—especially alloy steels—materials were now flowing more steadily.

Another matter reported at the meeting was that the level of employment had remained fairly steady over all industries in the region, although in South London there had been a definite decline in some sections of engineering. It was also mentioned, in connection with the building industry, that during August brick production in the region totalled over 36,000,000, and that unsold stocks at the end of that month were only 8,368,000. In the view of the Ministry of Works, the general supply position was satisfactory. The monthly output of cement in the region was given as 324,196 tons, it being reported that there were no shortages.

Railway Wages

On Monday and Tuesday of this week, the Railway Staff National Tribunal considered the claim for a 10 per cent increase in railwaymen's wages, which was put forward by the three railway unions last June, and rejected by the Railway Executive. In September last year, railway workers were awarded an increase of approximately 8 per cent on existing wage rates, and the present claim was based on the rise in the cost of living since then. It has been estimated that the claim, if granted, would add about £17,000,000 a year to the railways' wages bill.

At Monday's session of the Tribunal, Mr. J. B. Figgins, general secretary of the National Union of Railwaymen, asserted that unless something was done quickly to make railwaymen's rates of pay comparable with those paid for jobs of similar responsibility in outside industry, the shortage of men in the operating grades was likely to continue. It had been stated, Mr. Figgins continued, that wage increases could only be considered provided there was increased productivity, and on those grounds alone he urged that the present claim was justified. The railways were handling a larger volume of traffic than ever before and, in spite of handicaps, were handling it more expeditiously. Statements in support of the claim were also made by Mr. J. G. Batey, general secretary of the Associated Society of Locomotive Engineers and Firemen, and Mr. G. B. Thorneycroft, of the Transport Salaried Staffs Association.

On Tuesday, reply was made on behalf of the Railway Executive by Mr. W. P. Allen, the labour relations member. Mr. Allen said that the Executive was quite unable to make any offer to dispose of the claim which it did not consider was justified. It was a matter of concern, Mr. Allen added, that the Tribunal had been called upon for the second time in twelve months to determine a major wage claim. The probable net receipts of British Railways in 1952 and the prospective net receipts provided no margin to meet this new wage claim.

Notes and Memoranda

Rail and Road

ROAD EXPENDITURE.—A report issued by the International Road Federation contains details of road expenditure programmes in Europe and other items concerning road development works. It states that road expenditure in the U.K. is likely to amount to £67 million, compared with £50 million last year. This expenditure will allow only 70 per cent of pre-war maintenance to be carried out. The report estimates that arrears of maintenance work alone amount to £200 million and it maintains that trunk roads are being resurfaced at the rate of once every forty-two years as against the pre-war rate of once every nineteen years.

ALL-STEEL WAGONS FOR BRITISH RAILWAYS.—It is announced that the Railway Executive has arranged with the Wagon Building Association to build all-steel, 16-ton mineral wagons for the five years 1953–57. Contracts for 57,490 wagons have been placed to date with the following firms, and further contracts are pending: Birmingham Railway Carriage and Wagon Company, Ltd. (10,000); Butterley Company, Ltd. (5000); Cambrian Wagon and Engineering Company, Ltd. (10,500); Derbyshire Carriage and Wagon Company, Ltd. (4600); P. and W. MacLellan Company, Ltd. (4550); Metropolitan-Cammell Carriage and Wagon Company, Ltd. (13,000), and the Tees Side Bridge and Engineering Works, Ltd. (9840).

KING'S CROSS CENTENARY EXHIBITION.—The celebrations commemorating the centenary of King's Cross Station and the opening of the Peterborough-Retford section of the former G.N.R. main line are to conclude with an exhibition at King's Cross Station, from October 13th to 18th. The exhibition, which is being arranged by British Railways, will be open daily from 10 a.m. to 8 p.m. It will include scale models of former G.N.R. locomotives which were famous in their day, as well as models of their successors, together with original drawings of locomotives and carriages and collections of photographs, old documents, minute books and timetables. Another section of the exhibition will comprise a selection of locomotives and rolling stock, both ancient and modern. Tickets of admission to the exhibition (price 1s.) are to take the form of railway tickets in the old G.N.R. colour and will be dated by one of the original Edmundson ticket-dating machines.

LAST MIDLAND RAILWAY 4–4–0 PASSENGER ENGINE.—The withdrawal of London Midland locomotive No. 40726 renders extinct the Class "3P" tender engines of the old Midland Railway. This engine was fifty years old on withdrawal and it was one of eighty of the class which first appeared in 1900. Designed by Mr. S. W. Johnson, who was the Midland Railway Locomotive Superintendent of that time, these engines broke away from the previous Midland designs of round-topped boilers, curving splashers and Salter safety valves. Instead, a Belpaire boiler was used, with Ramsbottom safety valves, and the rear splasher was rectangular and separated from the front one. In the earlier days of their life the Class "3's" performed good work on express trains on the Midland main line, particularly between Derby and Manchester, over the severely graded Peak route, and they continued on such workings until replaced by the larger compounds. Later they were relegated to secondary duties and finally on local passenger train haulage.

Air and Water

PREVENTION OF OIL POLLUTION.—The Ministry of Transport has now announced the composition of the committee which is to consider what practical measures can be taken to prevent pollution of the sea by oil. Mr. P. Faulkner is the chairman of the committee. The members include representatives of the General Council of British Shipping, the oil companies, the Dock and Harbour Authorities' Association, the British Transport Commission, the Dry Dock Owners and Repairers Central Council, the Ministry of Agriculture, the Admiralty, the Ministry of Transport, and the Department of Scientific and Industrial Research.

RETIREMENT OF NAVAL ARCHITECT.—The Cunard Steam Ship Company announce that the company's naval architect, Mr. L. McEwan, retired on September 30th and that he has been succeeded by Mr. R. K. Wood, B.Sc., the assistant naval architect. Mr. McEwan joined the Cunard Line from John Brown and Co., Ltd., in 1919, and was associated with the design of the "Queen Mary" and "Queen Elizabeth." but more particularly with the second "Mauretania." Mr. Wood served his apprenticeship with John Brown and Co., Ltd., and became a member of the staff of the Cunard Company in 1931. He became a member of the Royal Corps of Naval Constructors in 1936 and served until 1951, when he returned to the Cunard Company as Assistant Naval Architect.

AIR TRAFFIC FOR AUGUST, 1952.—Air transport movements recorded at United Kingdom aerodromes in August, 1952, totalled 27,471, being 7·1 per cent more than in August, 1951. Passengers handled totalled 467,095, an increase of 17·8 per cent on the number for August, 1951, whilst freight on and off loaded at 4876·9 short tons, showed a decrease of 29·3 per cent. At London Airport there were 4113 air transport movements (a decrease of 0·4 per cent from August, 1951), and passengers handled totalled 111,121 (an increase of 11 per cent). Northolt recorded 5715 transport movements, an increase of 8·7 per cent, while passengers handled increased by 7·5 per cent to 114,352. Other airports at which passenger traffic increased considerably over August, 1951, were Isle of Man (Ronaldsway); 32,283 (43·6 per cent increase); Manchester (Ringway), 31,618 (48·5 per cent increase); Glasgow (Renfrew), 26,502 (26·7 per cent increase); Prestwick, 24,909 (57·5 per cent increase), and Belfast (Nutts Corner), 24,659 (18·3 per cent increase). Edinburgh (Turnhouse) passengers increased by 168·1 per cent to 5188. Jersey Airport handled 55,440 passengers, an increase of 28·4 per cent, and Guernsey, 22,318, an increase of 26·3 per cent.

Miscellanea

JUNIOR INSTITUTION OF ENGINEERS.—Air Commodore F. R. Banks, C.B., has accepted an invitation to continue as president of the Junior Institution of Engineers for 1952–53.

THE LATE MR. A. E. RYELAND.—We regret to have to record the death of Mr. Albert Edwin Ryeland, which occurred on October 2nd. Mr. Ryeland was a director of E. Boydell and Co., Ltd., Old Trafford, Manchester, having been associated with that company since its inception.

POWER SYSTEM TRANSIENTS.—An advanced course of lectures on "Power System Transients" is to be given on six Saturday mornings at the Heriot-Watt College, Edinburgh, beginning on October 18th. The lectures, followed by discussion, will last from 9.30 a.m. to 12 noon. The fee for the course is two guineas.

OIL PROSPECTING.—A seismic exploration party has started work at Screveton, 7 miles south of Eakring, Notts. The area has already been examined by the seismic refraction method and will be re-examined by seismic reflection method to locate the culmination of the anticline and the point where the potentially oil-bearing rock is nearest the surface.

"FLEXIBLES" CENTRE.—On Tuesday, September 30th, the Compoflex Company, Ltd., opened its new showrooms at 26, Grosvenor Gardens, London, S.W.1. The rooms house samples and installation photographs of hundreds of different "flexibles" and an advisory service is available to assist manufacturers on matters concerning the use of flexible tubing and hose.

COOLING TOWERS.—The Visco Engineering Company, Ltd., Stafford Road, Croydon, England, has issued a revised edition of its booklet *Visco Water Cooling*. In addition to the material contained in the 1947 edition, are pages illustrating typical concrete and steel shell coolers erected in recent years. A number of pages are devoted to tables relating to cooling and flow factors, and world meteorological data is included.

DIESEL TRACTORS.—We are informed by Mackay Industrial Equipment, Ltd., that Allis-Chalmers tractors, models H.D.9 and H.D.15 have recently undergone Nebraska Tests, the results of which indicate that higher horsepower and greater drawbar pull are developed than given in the provisional specifications. The drawbar horsepower for model H.D.9 is raised from 70 to 72, and the maximum drawbar pull from 16,650 lb to 19,030 lb. the corresponding figures for model H.D.15 are 102 h.p. increased to 109 h.p., and the pull increased from 24,750 lb to 29,400 lb.

BRITISH COMPRESSED AIR SOCIETY.—Members of the British Compressed Air Society are to have a new name sign for display on their exhibition stands and in their offices and showrooms, to draw attention to their membership of the Society. The sign is silkscreened in three colours, on ¼in clear perspex, and measures 12in by 10in, the colour scheme being light blue, yellow and white. The sign was designed by the Society's honorary publicity officer, and was printed by Sindall and Baker Publicity, Ltd., of Watford. The new sign is a first step in a publicity drive which the Society is planning to launch this autumn.

B.I.F. STAND CHARGES.—The Government is anxious that in Coronation year the British Industries Fair should be fully representative of the commercial life of the country and that overseas visitors should be given a comprehensive view of the goods which British industry can supply. It has been represented to the Board of Trade that this object would be helped if something could be done to reduce the cost of exhibiting at the Fair. The Board has decided to reduce the charge to exhibitors for shell stands at Olympia and Earls Court by approximately 9 per cent, and it is hopeful that industry will take the fullest advantage of this reduction. The Board of Trade will continue to consider applications for space up to October 25th, and the allocation of individual stands will be postponed until that date.

SOUTH WALES STEEL COMPANIES.—When nationalisation of the iron and steel industry took place, there were cross holdings of shares in the three South Wales companies, Richard Thomas and Baldwins, Ltd., the Steel Company of Wales, Ltd., and Guest Keen Baldwins Iron and Steel Company, Ltd. With the concurrence of the Iron and Steel Corporation of Great Britain, the share structure of these companies has now been simplified by transferring to the Corporation from the companies these cross holdings, so that the Corporation now holds all the shares of the companies directly. Following this transfer and by arrangement with the Iron and Steel Corporation of Great Britain, the boards of the companies have been reconstituted. Mr. E. H. Lever is chairman of Richard Thomas and Baldwins, Ltd., and the Steel Company of Wales, Ltd., and Mr. J. H. Jolly is chairman of Guest Keen Baldwins Iron and Steel Company, Ltd. The arrangements have been approved by the Minister of Supply.

CORROSION INHIBITOR.—Shell Petroleum Company, Ltd., states that the new chemical discovery, Shell V.P.I., a vapour phase inhibitor, has been under test for a considerable period as a corrosion and rust inhibitor and has proved successful. Two jet engines were left out in the open for two years, one was protected for the whole of the time by V.P.I. 260 and the other for part of the period, and one engine at the conclusion of the test was started up on hand priming and gave a full performance on a normal run-up. Again, two engines protected with V.P.I. and stored for six months in a humid atmosphere were run without fault for 1200 hours. It is claimed that V.P.I. has two advantages over the conventional methods of preservation in that it protects more extensively and the operations of preserving and depreserving are less costly. V.P.I., the active substance of which is a nitrite salt, dicyclohexlammonium nitrate, is slightly volatile and the vapour penetrates to every part of an engine, while a characteristic is that it does not react with or remove either moisture or oxygen but operates by actually inhibiting their corrosive action.

SOUTH BANK REDEVELOPMENT.—The London County Council has been recommended by its Town Planning Committee to purchase the Princes Meadows estate, with a quarter-mile frontage on to the River Thames, which covers 35 acres of land between Waterloo Bridge and Broad Wall to the east. In purchasing the Princes Meadows estate from the Duchy of Cornwall the L.C.C. is being recommended to reserve a site of approximately 5 acres immediately adjoining Waterloo Bridge for the erection by H.M. Government of a Science Centre, which, it is proposed, should become the home of the learned societies, the Patent Office and the Department of Scientific and Industrial Research. The decision to establish this Science Centre was first announced in Parliament on November 21, 1950. The Treasury has given authority to the London County Council to borrow money for the purchase of Princes Meadows estate. Construction of the new Science Centre would involve consideration of an extension of the river wall eastwards from Waterloo Bridge, a development which would enable the Council to reclaim more land from the river and to extend further the riverside open space towards which the reclamation of land by the construction of the river wall for the South Bank exhibition site has made so great a contribution. In the County of London Development Plan, 1951, the South Bank area, which includes the whole of the Princes Meadows estate, is envisaged as a southward extension of the central area of London and the proposals include the provision of buildings for central and local government purposes and for cultural, office, commercial, and industrial uses.

Personal and Business

MR. C. R. URQUHART has been elected a director of Foster Yates and Thom, Ltd.

W. EDWARDS AND CO. (LONDON), Ltd., has opened a technical sales and service establishment at 44, West George Street, Glasgow.

THE ENGINEERS' GUILD states that its head office address is now 78, Buckingham Gate, London, S.W.1 (telephone, Abbey 7315).

THE ENGLISH ELECTRIC COMPANY, Ltd., announces that the address of its central personnel services is now Marconi House, 336–7, Strand, London, W.C.2 (telephone, Temple Bar 1577).

MR. JOHN WALMSLEY, A.M.I.Mech.E., "Greenways," Two Gates, Tamworth, Staffs, has been appointed resident representative in the Midland counties of the Visco Engineering Company, Ltd., Croydon.

THE BRITISH BROADCASTING CORPORATION announces the retirement, under the age limit, of Mr. M. T. Tudsbery, C.B.E., M.I.C.E., its civil engineer. Mr. Tudsbery is being retained temporarily as consulting civil engineer.

MR. C. T. M. BAGNALL, publicity manager of The English Electric Company, Ltd., and Mr. S. H. Pryor, publicity manager of Igranic Electric Company, Ltd., have been appointed members of the BEAMA publicity committee.

THE BRUSH ABOE GROUP states that Mr. J. T. Rymer has resigned his position as managing director of Mirrlees, Bickerton and Day, Ltd. Mr. C. F. Barnard, assistant managing director, has been appointed general manager of Mirrlees, Bickerton and Day, Ltd.

SIR NOEL ASHBRIDGE, M.I.C.E., M.I.E.E., has been appointed a director of Marconi's Wireless Telegraph Company, Ltd., The Marconi International Marine Communication Company, Ltd., Marconi Instruments, Ltd., and The English Electric Valve Company, Ltd.

AUSTIN AND LANG (SALES), Ltd., Wembley, Middlesex, announces the formation of a new company named Lunzer Diamond Tools, Ltd., to deal with the manufacture and supply of Lunzer diamond tools. Burton Griffiths and Co., Ltd., has been appointed distributor of these tools.

THE LORD PRESIDENT OF THE COUNCIL has appointed Sir Wallace Akers, C.B.E., F.R.I.C., and Sir Philip Johnson to be members of the Advisory Council for Scientific and Industrial Research. Professor P. I. Dee has retired from the council on completion of his term of office and Sir Hugh Warren has resigned his membership because of the pressure of other duties.

THE BRITISH TANKER Company, Ltd., announces that Captain John Clairmont Lea, O.B.E., has been appointed Commodore of the Fleet, in succession to Captain Andrew Preece, O.B.E., and Mr. A. Aitken has been appointed Chief Engineer Superintendent as successor to Mr. H. S. Humphreys, who died last month. Another appointment announced is that of Mr. D. A. Davies as Engineer Commodore, in succession to Mr. J. G. Detchon.

British Patent Specifications

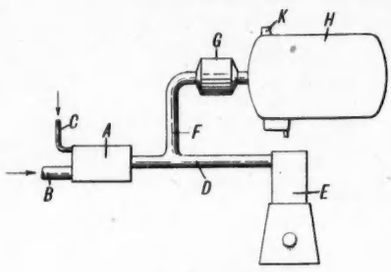
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

GAS TURBINES

678,736. April 3, 1950.—STORAGE APPARATUS FOR HOT GAS, Ricardo and Co. (1927), Ltd., 21, Suffolk Street, Pall Mall, London, S.W.1. (*Inventor: John Forster Alcock, "Highlands," Ring Road, North Lancing, Sussex.*)

Storage apparatus for hot gas according to the invention comprises a gas container for storing relatively cool gas under pressure and an inlet and outlet passage in which is arranged a heat regenerator through which the gas flows to and from the container. In the drawing the invention is shown as applied to a plant consisting essentially of a hot gas generator *A* in the form of a combustion chamber having an inlet *B* through which air is delivered under pressure and a fuel delivery pipe *C*. The fuel is burnt with the air and the hot gases of combustion are delivered through a pipe *D*



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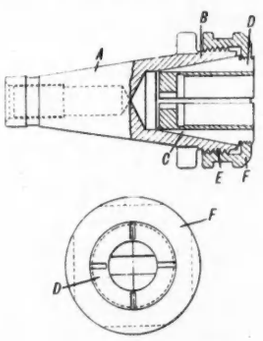
to a prime mover *E*. Communicating with the pipe *D* through a passage *F* is hot gas storage apparatus, according to the invention, comprising a heat storage regenerator *G*, through which gas can flow to and from a gas storage container *H*. The container may be provided with a safety plug, designed to fuse at a predetermined temperature, so that it will relieve pressure in the container if its temperature tends to exceed the safe limit for the material of which the container is formed. Modified designs are also shown in the specification.—*September* 10, 1952.

WORKSHOP TOOLS AND APPLIANCES

678,873. June 16, 1950.—CHUCKS FOR DRILLS, REAMERS, MILLING CUTTERS, &C., Clare Collets, Ltd., Wright Street, Broadheath, Altrincham, Cheshire. (*Inventor: Charles Henry Clare.*)

The invention is designed to provide means which permit easier releasing of its chuck after it has been used in heavy cutting operations. As the drawing shows, the chuck comprises a shank *A* with an internally coned body *B*, which receives the conical split collet *C* in which the tool shank is gripped. The outer end *D* of the collet which projects beyond the body and the end *E* of the shank body are threaded. A coupling piece *F* screws on to the end of the collet and the end of the body. The thread of the body and



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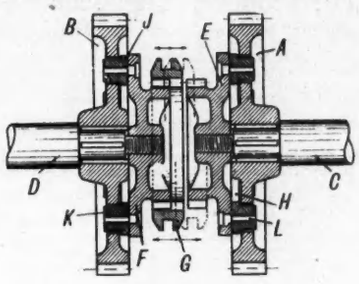
of the coupling piece where it screws on to the body is of different pitch from the thread of the collet at *D* and of the coupling where it screws on to *D* so that when the coupling is turned a differential action occurs between the collet and coupling. The thread on the body is of coarser pitch than that of the collet, and this causes a very strong binding action to be exerted on the collet when in service. This arrangement also enables the collet to be released with ease by turning the coupling by means of a key even after the heaviest cutting operations.—*September* 10, 1952.

AGRICULTURAL ENGINEERING

678,775. October 2, 1950.—LOCKING MEANS FOR DIFFERENTIAL GEARS ON TRACTORS, Willi Ernst Salzmann, 109, Bielstrasse, Solothurn, Switzerland.

Referring to the drawing, the large toothed wheels *A* and *B* of the tractor double-pinion drive are secured to the rear axle shafts *C* and *D*. On the two rear axle shafts, in place of conventional castle nuts, are screwed coupling members *E* and *F*, which are provided with coupling teeth and can be secured



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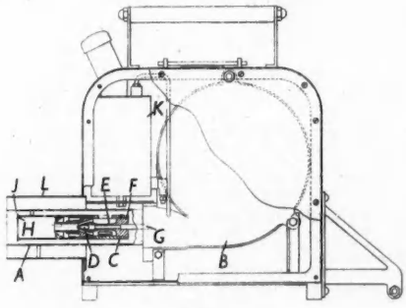
against relative rotation by a coupling ring *G*. The rotary driving force between each coupling member and its toothed wheel is transmitted through a carrier ring *H* or *J* arranged between each coupling member and its wheel. Each carrier ring has on one side driving projections *K*, which project between spokes or into apertures in the wheels. At the other side each carrier ring is secured to the coupling member by screws or bolts passing through holes *L*. The locking means is engaged and disengaged through rods or links which move the coupling ring *G* axially and are actuated by a lever on the tractor.—*September* 10, 1952.

HEAT EXCHANGERS

678,725. November 23, 1949.—AIR HEATERS, Nu-Way Heating Plants, Ltd., Vines Lane, Droitwich (formerly of 54, Gillhurst Road, in the city of Birmingham, 17.) (*Inventors: John Murray Hamilton and William Samuel Cook.*)

The invention is intended to provide an improved air heater for supplying heat to facilitate the starting of internal combustion engines, and also for other purposes. Referring to the drawing, there is provided a tubular sheet metal duct *A* for conducting air under pressure from any convenient fan *B* to a flexible delivery pipe, the duct being connected at its inlet end to the delivery side of the fan and at its outlet end to the pipe. The fan may be manually or power driven. Arranged in the duct *A* is a hollow cylindrical body *C* enclosing a liquid fuel nozzle *D* on one end of a hollow stem *E* which lies coaxially within the body, and which at its other end is formed with a boss *F* secured in and closing the ends of the body *C* nearest to the inlet end of the duct. This boss is connected to a petrol or other liquid fuel supply pipe *G*, from which fuel can flow through the stem



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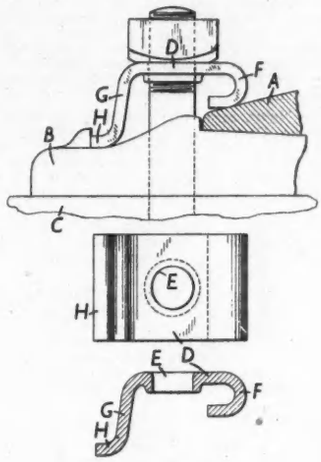
to the nozzle. The drawing shows the design and construction of the nozzle. To minimise any tendency of unburned fuel to emerge from its outer end the combustion chamber is provided with an internal flange *H*. Also the outer end of the combustion chamber is provided with a narrow external lip *J* for creating sufficient back pressure to ensure adequate air flow from the interior of the duct through the tangential openings and ports in the hollow body. When the fan is in action the air conducted by the duct *A* to the delivery pipe is mixed with and heated by the products of combustion emerging from the outer end of the combustion chamber, and can be led by the delivery pipe to the region required to be heated. The fuel tank *K* and fan *B* are enclosed by a casing provided with a handle for convenience in carrying. All air entering the casing passes through a tube *L*, where it is preheated by contact with the surface of the tube *A*.—*September* 10, 1952.

RAILWAY ENGINEERING

678,894. May 17, 1951.—SECURING RAILWAY RAILS TO SLEEPERS, Bayliss, Jones and Bayliss, Ltd., Victoria Works, Wolverhampton. (*Inventor: Frank Usher-Smith.*)

In the construction illustrated in the drawings one side *A* of the rail foot is shown supported by a metal chair *B* on a sleeper *C*. The chair is provided with a locating shoulder adjacent the edge of the rail foot. The clamping plate has a top portion *D*, through which extends a hole *E*. The plate also has two end portions, one of which is bent downwardly into a channel *F*, and the other to form a leg *G*. The lower



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end *H* of the leg *G* is bent outwards and forms a foot which bears upon the top of the chair and is prevented from moving by a suitable abutment on the chair. The clamping plate is made of hardened spring steel, and the channel *F* provides for resilient pressure on the rail foot, which is maintained under all the normal stresses encountered in service. The foot *H* extends outwards, enabling the clamping plate to resist any tendency to rock laterally in relation to the length of the rail.—*September* 10, 1952.

678,731. March 2, 1950.—PAD FOR USE WITH FLAT-BOTTOMED RAILS, The Clyde Rubber Works Company, Ltd., and Douglas Millar Hannah, both of the company's address at Porterfield Road, Renfrew, Scotland.

A pad, according to the invention, comprises a wedge-shaped slab of resilient material, preferably vulcanised rubber. The angle of inclination to one another of the two opposite main faces of the slab have a tangent of approximately 0·05. Each of the faces are formed with parallel grooves, the grooves in one face being at right angles to the grooves in the other face. In practice, when the pads are interposed between the soles of flat-bottomed rails and the associated sleepers the transverse grooves minimise rail creep and reduce any tendency for the pads themselves to creep. In addition, water gathering under the rails can drain out through the grooves, which also serve as ventilating passages to dissipate any heat. The longitudinal grooves on the face next to the sleeper minimise tendency for the rail to move outwards along the sleeper. The two sets of grooves co-operate to render the pad more readily compressible.—*September* 10, 1952.

ELECTRICAL ENGINEERING

678,656. March 30, 1951.—REMOVING THE INSULATION LAYER OF ENAMELLED WIRE, N. V. Philips' Gloeilampenfabrieken, Emmasingel 29, Eindhoven, Holland.

The insulating layer of the enamelled wire is treated with an organic sulphonic acid such as an aromatic sulphonic acid, and heated to a temperature of at least 200 deg. Cent., but preferably 300 deg. Cent. Carbonisation takes only a few seconds. The carbonised layer is readily wiped off the metal surface and residues of the chemicals used, which are liable subsequently to bring about corrosion, are removed. Satisfactory results are obtained with a 30 per cent

solution of toluene sulphonic acid or naphthalene sulphonic acid in water which has been admixed with 2 per cent polyoxyethylene-sorbitan-monolaurate as the wetting agent. However, a solution of sulphonic acid in dilute alcohol, for example a solution comprising 30 per cent toluene sulphonic acid, 35 per cent ethyl alcohol and 35 per cent water keeps better.—*September* 3, 1952.

Launches and Trial Trips

CLYDEFIELD, oil tanker ; built by Harland and Wolff, Ltd., Govan, for Hunting and Son, Ltd.; length between perpendiculars 515ft, breadth moulded 70ft, depth moulded 37ft 9in, deadweight 16,500 tons ; twenty-seven oil cargo tanks, one pump room ; Harland-B. and W. two-cycle, single-acting, opposed-piston oil engine, six cylinders, 750mm diameter by 2000mm combined stroke, 120 r.p.m. Launch, September 16th.

GLENMOOR, cargo ship ; built by R. and W. Hawthorn, Leslie and Co., Ltd., for the Moor Line, Ltd.; length between perpendiculars 423ft, breadth moulded 58ft, depth moulded to upper deck 29ft, deadweight 9350 tons, draught 25ft 8½in, service speed 13 knots ; five cargo holds, steam deck machinery, two 40kW generators ; Hawthorn-Doxford oil engine, four cylinders, 600mm diameter by 2320mm combined stroke, 3300 b.h.p. at 108 r.p.m. Launch, September 18th.

MASTER NICOS, cargo ship ; built by the Burntisland Shipbuilding Company, Ltd., for the Compania de Navigacion Oriental de Panama ; length between perpendiculars 435ft, breadth moulded 62ft, depth moulded to shelter deck 38ft 3in, deadweight 10,500 tons, draught 25ft 10½in ; five cargo holds, derricks complement includes two of 25 tons, two 40kW generators ; Sulzer two-stroke, single-acting diesel engine, six cylinders, 720mm diameter by 1250mm stroke, 3940 b.h.p. at 121 r.p.m Launch, September 19th.

CORBRAE, collier ; built by the Burntisland Shipbuilding Company, Ltd., for William Cory and Son, Ltd.; length between perpendiculars 258ft, breadth 39ft 3in, depth moulded 18ft 11in, deadweight 2760 tons, draught loaded 17ft 6½in ; four holds, electric deck machinery ; British Polar diesel engine, eight cylinders, 340mm diameter by 570mm stroke, 1050 b.h.p. Trial, September 22nd.

LONDON SPLENDOUR, oil tanker ; built by the Furness Shipbuilding Company, Ltd., for London and Overseas Freighters, Ltd.; length between perpendiculars 560ft, breadth moulded 80ft, depth moulded 42ft 3in, deadweight 24,650 tons, draught 32ft 3½in, trial speed 14 knots ; twenty-seven oil cargo tanks, two pump rooms, four 500 tons per hour pumps, two 75kW steam generators, one 35kW diesel generator ; Wallsend-Doxford oil engine, six cylinders, 670mm diameter by 2320mm combined stroke, 6600 b.h.p. at 116 r.p.m., two Scotch boilers. Launch, September 22nd.

MIDDLESEX, cargo liner ; built by Alexander Stephen and Sons, Ltd., for the Federal Steam Navigation Company, Ltd. ; length 469ft 6in, breadth 64ft 5in, depth 42ft, load draught 27ft 4in, deadweight 10,300 tons ; sea speed 16 knots ; five cargo holds, 10-ton derricks and one 50-ton derrick ; two Stephen-Sulzer diesel engines, geared to one shaft through electro-magnetic couplings. Launch, September 23rd.

HAROLD SLEIGH, oil tanker ; built by the Blythswood Shipbuilding Company, Ltd., for the Singapore Navigation Company, Ltd. ; length between perpendiculars 460ft, breadth 61ft, moulded depth 34ft 1in ; twenty-seven oil cargo tanks, two pump rooms, four 270 tons per hour steam-driven oil cargo pumps ; Kincaid-B. and W. single-acting, four-stroke, diesel engine, six cylinders, 740mm diameter by 1500mm stroke, 3600 b.h.p., two multi-tubular marine boilers. Launch, September 24th.

WINDSOR, cargo ship ; built by Barclay Curle and Co., Ltd., for the Britain Steamship Company, Ltd. ; length between perpendiculars 435ft, breadth moulded 58ft 6in, depth moulded to shelter deck 38ft, draught 27ft, deadweight 9950 tons ; six holds including one deep tank, 10-ton derricks, steam deck machinery ; Barclay Curle-Doxford oil engine, four cylinders, 670mm diameter by 2320mm combined stroke, Bibby detuner flywheel, 4400 b.h.p. at 115 r.p.m., four 75kW generators, service speed 13 knots. Trial, September 25th.

LOUIS LUMIERE, passenger and cargo liner ; built by the Chantiers et Ateliers de Saint-Nazaire Penhoet for the Compagnie Maritime des Chargeurs Reunis ; length between perpendiculars 502ft, breadth moulded 64ft 4in, depth to main deck 41ft, draught 27ft 11in, deadweight 9500 tons ; 110 first-class, 226 third-class and 100 fourth-class passengers ; five holds, 5 and 8-ton derricks ; two Sulzer two-stroke, single-acting, diesel engines, eight cylinders, 720mm diameter by 1250mm stroke, 10,000 b.h.p. (total) at 120 r.p.m., four 240kW diesel generators ; service speed 17 knots. Trial, September.

SUNDA, cargo liner ; built by John Brown and Co., Ltd., for the P. and O. Steam Navigation Company ; length 525ft, deadweight 11,600 tons ; one set of geared turbines, 13,000 s.h.p., service speed 18 knots. Trial, October 2nd.

CHINKOA, cargo liner ; built by Barclay Curle and Co., Ltd., for the British India Steam Navigation Company, Ltd. ; length 485ft, breadth 62ft 6in, depth to shelter deck 40ft 9in, gross tonnage 9000 ; five cargo holds, 6 and 10-ton derricks, one each of 30 tons and 20 tons capacity ; Barclay Curle-Doxford oil engine, six cylinders, 670mm diameter by 2320mm combined stroke, 6800 b.h.p. at 116 r.p.m., two multi-tubular boilers. Launch, October 2nd.

FERDINAND DE LESSEPS, passenger liner ; built by the Forges et Chantiers de la Gironde for Compagnie des Messageries Maritimes ; length between perpendiculars 459ft 4in, breadth 63ft 4in, depth to upper deck 38ft 5in, draught 24ft 3in, deadweight 6100 tons ; eighty-eight first-class, 112 tourist-class and 292 third-class passengers ; six holds ; two Creusot-Burmeister and Wain diesel engines, ten cylinders, 620mm diameter by 1150mm stroke, 6000 b.h.p. each, two La Mont boilers, four 480kW diesel generators ; service speed 17 knots. Trial, October.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, Oct. 10th.—CREWE BRANCH : Copeland Arms Hotel, Glebe Street, Stoke-on-Trent, "Fluorescent and Cold Cathode Lighting," C. R. Bicknell, 7.30 p.m.
Tues., Oct. 14th.—BOLTON BRANCH : Balmoral Hotel, Bradshawgate, Bolton, "The Ductube System," 7.30 p.m.
Wed., Oct. 15th.—MANCHESTER BRANCH : Engineers' Club, Albert Square, Manchester, Lecturettes by Members, 7.30 p.m. —S.W. LONDON BRANCH : The Guild House, 32, Worple Road, Wimbledon, "Single Phase Motors," A. N. D. Kerr, 8.15 p.m.

CHEMICAL SOCIETY

Thurs., Oct. 16th.—Burlington House, Piccadilly, London, W.1, "The Stereochemistry of *cyclo* Hexane Derivatives," D. H. R. Barton, 7.30 p.m.

COMMUNICATION TRAINING CENTRE

Thurs., Oct. 16th.—Management House, 8, Hill Street, London, W.1, "The Presentation of Technical Information," Professor Reginald O. Kapp, B. C. Brookes and Alvin C. Leyton, 6 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., Oct. 13th.—SHEFFIELD CENTRE : The University, Western Bank, Sheffield, "Hospital Lighting," M. W. Peirce and D. J. Reed, 6.30 p.m.
Tues., Oct. 14th.—LONDON CENTRE : Royal Institution, Albemarle Street, W.1, Presidential Address, W. J. Wellwood Ferguson, 6 p.m.
Wed., Oct. 15th.—TEES-SIDE GROUP : Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "Black Light," H. L. Privett, 6.30 p.m.

INCORPORATED PLANT ENGINEERS

Mon., Oct. 13th.—DUNDEE BRANCH : Mathers Hotel, Dundee, "Safety First," W. B. S. McLean, 7.30 p.m.
Tues., Oct. 14th.—E. LANCASHIRE BRANCH : Engineers Club, Albert Square, Manchester, "Power Factor Correction," C. W. Sutcliffe, 7.15 p.m.——EDINBURGH BRANCH : 25, Charlotte Square, Edinburgh, "Insulation," 7 p.m.
Wed., Oct. 15th.—KENT BRANCH : Bull Hotel, Rochester, "Foundations," C. R. Glover, 7 p.m.

INDUSTRIAL WELFARE SOCIETY

Fri., to Mon., Oct. 17th to 20th.—Ashridge, Berkhamsted, Herts, Week-end Conference for Foremen and Forewomen, "What Should the Foreman Do ?"

INSTITUTE OF ECONOMIC ENGINEERING

Tues., Oct. 14th.—Radiant House, Bold Street, Liverpool, Film Show, "Punched Cards as an Aid to Production Control."

INSTITUTE OF FUEL

Tues. and Wed., Oct. 28th and 29th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, Conference, "A Special Study of Ash and Clinker in Industry."

INSTITUTE OF INDUSTRIAL SUPERVISORS

Thurs., Oct. 16th.—LONDON S.E. SECTION : The Polytechnic, Woolwich, "The Century of the Foremen," Miss Patricia Hall, 7.30 p.m.

INSTITUTE OF NAVIGATION

Fri., Oct. 17th.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, Annual General Meeting, Navigation and Hydrography, Presidential Address, A. Day, 3 p.m.

INSTITUTE OF PETROLEUM

Wed., Oct. 15th.—STANLOW BRANCH : Grosvenor Hotel, Chester, "The Kirkuk-Banias Pipeline," H. S. Gibson, 7.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

To-day, Oct. 10th.—S. WALES GROUP : S. Wales Institute of Engineers, Park Place, Cardiff, "Dieselisation," H. Parrish, 7 p.m.
Tues., Oct. 14th.—MIDLANDS CENTRE : Crown Inn, Broad Street, Birmingham, "Air and Oil Filters," E. A. Stokes, 7.30 p.m.
Wed., Oct. 15th.—N.W. CENTRE : Victoria Hotel, Wigan, Short Papers by Members, 7.30 p.m.——E. MIDLANDS' CENTRE : Mechanics Institute, Nottingham, Centre Annual General Meeting, 7.30 p.m.
Thurs., Oct. 16th.—Hotel Metropole, Leeds, "Various Trends in Machining and Inspecting Methods in the Manufacture of Heavy Commercial Vehicles," E. I. Perry, 7.30 p.m.

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS

Tues., Oct. 14th.—Institution of Electrical Engineers, Savoy Place, London, W.C.2, "The Problems of the Development Worker," F. W. McConnel, 2.15 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., Oct. 14th.—Geological Society, Burlington House, Piccadilly, London, W.1, "Pneumatic Conveying, Part I, The Pressure Drop During Horizontal Conveyance," D. M. Newitt, J. F. Richardson, R. H. Clark and D. E. Charles, 5.30 p.m.
Thurs., Oct. 16th.—N.W. CENTRE, GRADUATES' AND STUDENTS' SECTION : Queen Hotel, City Road, Chester, "Chemical Engineering Theory and Practice in the U.S.A.," A. F. Thompson, 7 p.m.
Fri., Oct. 17th.—LONDON GRADUATES' AND STUDENTS' SECTION : Caxton Hall, Westminster, S.W.1, Conversazione, "The Development of a Chemical Engineering Project," 6.30 p.m. ——N.E. CENTRE, GRADUATES' AND STUDENTS' SECTION : Chemical Engineering Department, Stephenson Building, Claremont Road, Newcastle upon Tyne, "Gas Engineering," A. J. Pringle, 6.15 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Oct. 14th.—AIRPORT ENGINEERING DIVISION : Great George Street, Westminster, London, S.W.1, "The Organisation of Airport Construction," E. A. Palmer, 5.30 p.m.
Thurs., Oct. 16th.—N.W. ASSOCIATION : The University, Manchester, "Water Conservation in Australia," L. R. East, 6.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Oct. 13th.—LONDON STUDENTS' SECTION : Savoy Place, W.C.2, "The Protection of Running Buses," B. L. A. Ellings, 7 p.m.
Tues., Oct. 14th.—EDUCATION DISCUSSION CIRCLE : Savoy Place, London, W.C.2, Discussion on "The Teaching of Chemistry to Engineers," opened by J. E. Garside, 6 p.m.
Wed., Oct. 15th.—RADIO SECTION : Savoy Place, London, W.C.2, Chairman's address, E. C. S. Megaw, 5.30 p.m.—— SOUTHERN CENTRE : S.E.B. Showrooms, 17, New Canal, Salisbury, "The Electricity Supply Industry," E. A. Logan, 6.30 p.m.

INSTITUTION OF ENGINEERING INSPECTION

Fri., Oct. 17th.—DUNDEE SECTION : School of Economics, Bell Street, Dundee, "Introduction to Gear Checking," W. C. Mitchell, 7.15 p.m.——S.W. SECTION : Grand Hotel, Bristol, "Plastics History, Types and Uses," T. T. Clarke, 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Oct. 14th.—39, Elmbank Crescent, Glasgow, Presidential Address, Sir William Wallace, 6.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Thurs., Oct. 16th.—Dorchester Hotel, Park Lane, London, W.1, Annual Dinner, 7 p.m.
Fri., Oct. 17th.—GENERAL MEETING : Storey's Gate, St. James's Park, London, S.W.1, Presidential Address, Sir David Pye, "The Art of the Practical Engineer," 5.30 p.m.

INSTITUTION OF MINING AND METALLURGY

Thurs., Oct. 16th.—Geological Society, Burlington House, Piccadilly, London, W.1, "Graduates in Metal Mining : Notes on Their Status, Training and Vocation," J. B. Richardson; "Recovering a Flooded Shaft in the O.F.S. Goldfield," R. S. Cooke, 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

To-day, Oct. 10th.—E. COUNTIES SECTION : Britannia Works, Colchester, "The Corby Iron and Steel Works of Stewarts and Lloyds, Ltd.," E. A. Taylor, 7.30 p.m.——STOKE-ON-TRENT SECTION : Works Visit to Josiah Wedgewood and Sons, Ltd., Barlaston, Stoke-on-Trent, 10.15 a.m.
Mon., Oct. 13th.—STOKE-ON-TRENT SECTION : North Staffordshire Technical College, Victoria Road, Stoke-on-Trent, "The Engineer's Part in the Production of Pottery," J. Robinson, 7.15 p.m.——YORKSHIRE SECTION : Hotel Metropole, King Street, Leeds, 1, "Some Aspects of the Study of Working Methods," A. B. Armstrong, 7 p.m.
Wed., Oct. 15th.—BIRMINGHAM SECTION : James Watt Memorial Institute, Great Charles Street, Birmingham, "Standardisation," H. E. Merritt, 7 p.m.——EDINBURGH SECTION : North British Station Hotel, Princes Street, Edinburgh, "Corrugated Case Manufacture," J. W. Haig Ferguson, 7.30 p.m.—— HALIFAX GRADUATE SECTION : White Swan Hotel, Halifax, "The Production of Radio and Television Units," T. W. Atkinson, 7.15 p.m.——S. ESSEX SECTION : Mid-Essex Technical College, Chelmsford, "Dimensional Control in Production," E. Clarke, 7.30 p.m.
Thurs., Oct. 16th.—MANCHESTER GRADUATE SECTION : Reynolds Hall, College of Technology, Sackville Street, Manchester, 1, "Schofield Scholarship," F. W. Walton, 7.15 p.m.—— SOUTHERN SECTION : Polygon Hotel, Southampton, "Comet," H. Povey, 7 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Tues., Oct. 14th.—NORTHERN COUNTIES BRANCH : Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, Chairman's Address, A. V. Buttress, 6.30 p.m.
Wed., Oct. 15th.—NORTHERN COUNTIES BRANCH : Neville Hall, Newcastle, Chairman's Address, A. V. Buttress, 6.30 p.m.
Fri., Oct. 17th.—WALES AND MONMOUTHSHIRE BRANCH : S. Wales Institute of Engineers, Park Place, Cardiff, Chairman's Address, R. D. Heseltine, 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Oct. 10th.—Townsend House, Greycoat Place, London, S.W.1, "Electricity and Productivity," H. J. Gibson, 7 p.m.
Mon., Oct. 13th.—N.W. SECTION : Geographical Society, 16, St. Mary's Parsonage, Manchester, Presidential Address, 7 p.m.——SHEFFIELD AND DISTRICT LOCAL SECTION : Livesey Clegg House, Sheffield, Annual General Meeting, Chairman's Address, "Some Features of the Rolling of Steel Sections," W. H. Bailey, 7.30 p.m.
Fri., Oct. 17th.—INFORMAL MEETING : Townsend House, Greycoat Place, London, S.W.1, "Water Divining," K. W. Merrylees, 7 p.m.

NEWCOMEN SOCIETY

Wed., Oct. 15th.—Textile Institute, 10, Blackfriars Street, Manchester, 3, "James Hargraves and the Invention of the Spinning Jenny," W. A. Hunter, 6.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Fri., Oct. 17th.—Literary and Philosophical Society, Newcastle upon Tyne, Presidential Address, T. Eustace Smith.

OLD CENTRALIANS

Tues., Oct. 14th.—Chez Auguste Restaurant, 47, Frith Street, London, W.1, "Distribution," R. Gaudin, 12.55 p.m.

ROYAL STATISTICAL SOCIETY

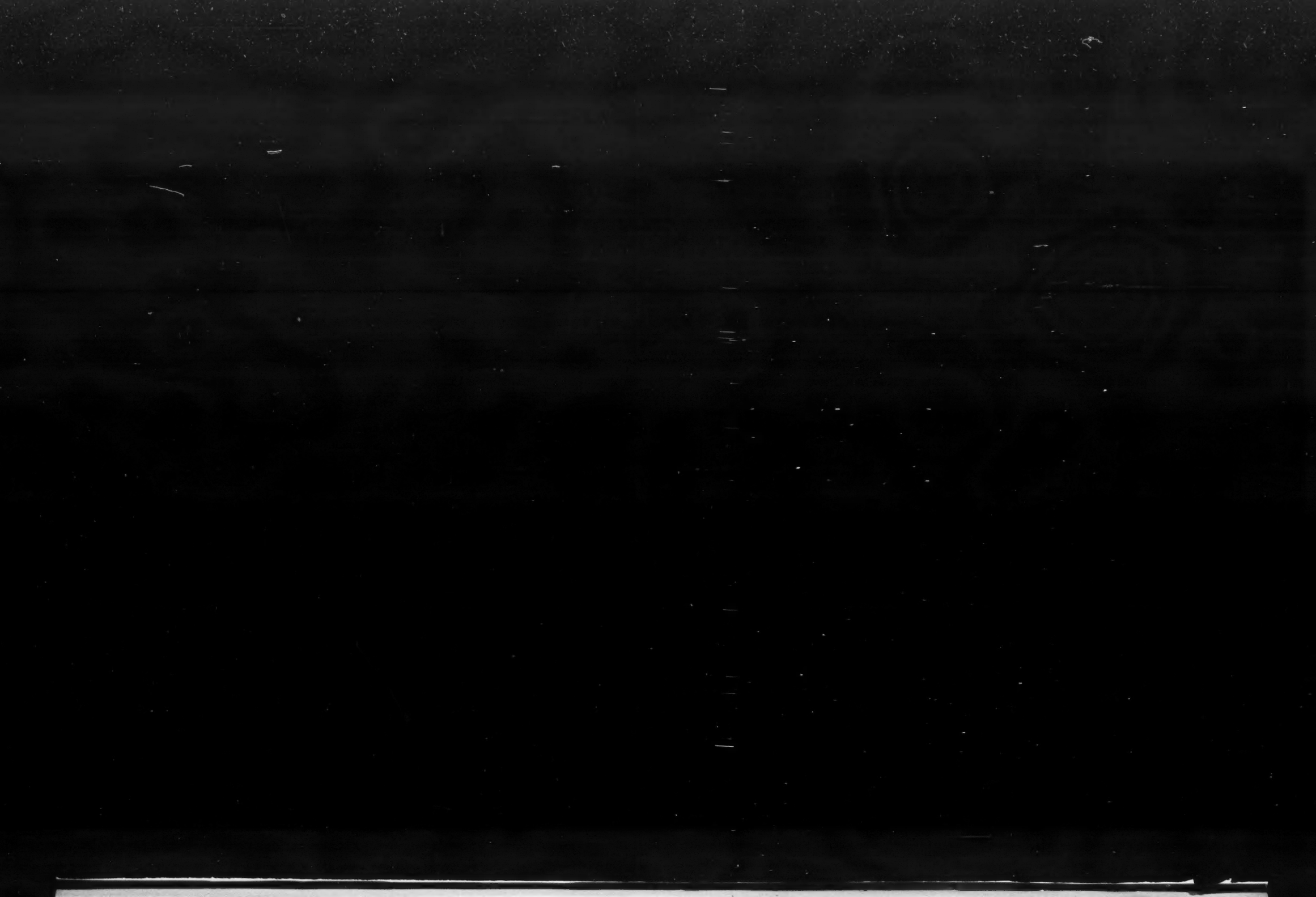
Wed., Oct. 15th.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, C.2, "Control Chart Techniques as an Aid to Supervisory and Executives Staff," B. P. Dudding, 7.30 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Thurs., Oct. 16th.—ROAD AND BUILDING MATERIALS GROUP : Building Centre, Store Street, Tottenham Court Road, London, W.C.1, "Road Problems Arising from Snow and Ice," A. C. Whiffin and W. I. J. Price, 6 p.m.

STOKE-ON-TRENT ASSOCIATION OF ENGINEERS

Wed., Oct. 15th.—Victoria Hall, Harley, "Locomotive Development, Past, Present and Future," Sir William Arthur Stanier, 7 p.m.

WOMEN'S ENGINEERING SOCIETY

Mon., Oct. 13th.—35, Grosvenor Place, London, S.W.1, "Meteorology and the Engineer," 7 p.m.